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PALÆONTOGRAPHICAL SOCIETY.

BRITISH CARBONIFEROUS BRACHIOPODA.

PART V.

BRITISH FOSSIL REPTILIA FROM THE OOLITIC FORMATIONS.

PART SECOND.

SCELIDOSAURUS HARRISONII AND PLIOSAURUS GRANDIS.

THE FOSSIL ESTHERIÆ.

FOSSIL MALACOSTRACOUS CRUSTACEA OF GREAT BRITAIN.

PART II.

CRUSTACEA OF THE GAULT AND GREENSAND.

1862.

ISSUED FOR THE YEAR 1860.

PALÆONTOGRAPHICAL SOCIETY.

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The Council request that all subscriptions be paid by Members directly to the Treasurer, Searles Wood, Esq., Brentwood, Essex, by Post-Office Order on the *London Office*, or by Cheque on a *London* Banker.

The Members have received the following works:

1847. 'The Univalves of the Crag,' by Mr. S. V. Wood, 21 plates.
1847. 'The Cephalopoda of the London Clay,' by Mr. F. E. Edwards, 9 plates.
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1854. 'British Fossil Reptiles of the Wealden Period,' by Prof. Owen, 20 plates.
1854. 'Mollusca of the Great Oolite,' by Messrs. Morris and Lycett, Part III, 7 plates.
1854. 'The Fossil Corals of Great Britain,' by Profs. H. Milne-Edwards and Jules Haime, Part V, 16 plates.
1854. 'The Fossil Balanidæ and Verrucidæ of Great Britain,' by Mr. Charles Darwin, 2 plates.
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1854. 'Eocene Mollusca,' by Mr. F. E. Edwards, Part III, 8 plates.
1855. 'The British Fossil Echinodermata,' by Dr. Wright, Part I, 10 plates.
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1856. 'British Fossil Echinodermata,' by Dr. Wright, Part II, 12 plates.
1856. 'British Fossil Crustacea of the London Clay,' by Prof. Bell, 11 plates.
1856. 'British Permian Brachiopoda,' by Mr. Davidson, 4 plates.

1856. 'British Carboniferous Brachiopoda,' by Mr. Davidson, 8 plates.
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1857. 'Fossil Reptilia of the Wealden Formations,' by Prof. Owen, Part V, 12 plates.
1857. 'Fossil Polyzoa of the Crag,' by Prof. Busk, 22 plates.
1858. 'British Fossil Echinodermata,' by Dr. Wright, Part IV, 7 plates.
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1858. 'Fossil Reptilia of the Wealden Formations,' &c., by Prof. Owen, 8 plates.
1858. 'British Carboniferous Brachiopoda,' by Mr. Davidson, Part V, third portion, 9 plates.
1859. 'British Carboniferous Brachiopoda,' by Mr. Davidson, Part V, fourth portion, 20 plates.
1859. 'Fossil Reptilia from the Oolitic Formations,' by Prof. Owen, Part I, 7 plates.
1859. 'Eocene Mollusca,' by Mr. S. V. Wood, Part I, Bivalves, 13 plates.
1860. 'British Carboniferous Brachiopoda,' by Mr. Davidson, Part V, fifth portion, 7 plates.
1860. 'British Fossil Reptilia from the Oolitic Formations,' by Prof. Owen, Part II, 12 plates.
1860. 'British Fossil Crustacea of the Gault and Greensand,' by Prof. Bell, 11 plates.
1860. 'British Fossil Estheriæ,' by Prof. Jones, 5 plates.
1861. 'British Fossil Echinodermata from the Oolitic Formations,' Part I, Asteroidea, by Dr. Wright, 13 plates.
1861. 'Supplementary Monograph on the Mollusca of the Great Oolite,' &c., by Dr. Lycett, 17 plates.

The following is a list of the Works in progress for distribution for 1862 *and succeeding years:*

1st. 'Eocene Mollusca (Univalves),' by Mr. F. E. Edwards.
2nd. 'Eocene Mollusca (Bivalves),' by Mr. S. V. Wood.
3rd. 'Fossil Reptilia of Great Britain,' by Prof. Owen.
4th. 'British Devonian and Silurian Brachiopoda,' by Mr. Davidson.
5th. 'The Polyzoa of the Chalk Formation,' by Prof. Busk.
6th. 'The Fossil Elephants of Great Britain,' by Dr. Falconer.
7th. 'The Entomostraca of the British Wealden, Oolitic, and Liasic Deposits,' by Mr. T. R. Jones.
8th. 'A Monograph of the British Cretaceous Foraminifera,' by Mr. T. R. Jones and Mr. W. K. Parker.
9th. 'The Radiaria of the Cretaceous Formations,' by Dr. Wright.
10th. 'The Trilobites of the Mountain Limestone, Devonian and Silurian Formations,' by Mr. J. W. Salter.
11th. 'A Monograph of the Fossil Graptolites of Great Britain,' by Prof. Wyville Thomson.
12th. 'A Monograph of the Placoid Fishes of the Mountain Limestone of Great Britain,' by Prof. Melville.
13th. 'A Monograph of the Carboniferous Fossils of Great Britain, exclusive of the Corals, Brachiopoda, and Trilobites,' by Prof. Melville.

The Members are respectfully reminded that the production of the Monographs necessarily involves a considerable expenditure of money many months before they can be ready for delivery; an early payment of the Annual Subscriptions is therefore highly desirable.

DIRECTIONS FOR BINDING.

Works completed.

Mr. S. V. Wood's 'Univalves and Bivalves of the Crag Formation,' 1 or 2 volumes.
There is a Supplemental Note to this work in the volume for 1858.

Prof. William King's 'Permian Fossils,' 1 volume.
There is a Supplement to this work in the volume issued for 1854.

Prof. Milne-Edwards and Jules Haime's 'Fossil Corals of Great Britain.'
A Supplement to this work is published in the volume issued for 1854.

Prof. Morris and Dr. Lycett's 'Mollusca of the Great Oolite,' and Dr. Lycett's Supplement, issued for 1861, 1 or 2 volumes.

Mr. Davidson's 'Fossil Brachiopoda,' 2 volumes, completed, including the part issued for 1860.

Mr. Darwin's 'Fossil Lepadidæ, Balanidæ,' &c., 2 parts, 1 volume.

Prof. E. Forbes' 'Radiaria of the Crag and London Clay,' 1 thin volume.

Prof. Busk's 'Fossil Polyzoa of the Crag,' 1 volume.

Works not completed.

F. E. Edwards' 'Cephalopoda and Eocene Mollusca of London Clay.'

Prof. Owen's 'Fossil Reptilia.'
The Chelonia and the Crocodilia and Ophidia of the London Clay may form 1 volume if it please the possessors, but the work, as a whole, is not completed. There are supplemental plates and descriptions in the volume for 1849-50, and in that for 1856.

Prof. T. R. Jones' 'Fossil Entomostraca of the British Formations.'

Mr. Sharpe's 'Fossil Shells of the Chalk.'
An incomplete work as regards the subject, but completed as regards the deceased author.

Dr. Wright's 'Fossil Echinodermata.'

Prof. Bell's 'Fossil Crustacea of the British Formations.'

Mr. S. V. Wood's 'Eocene Mollusca (Bivalves).'

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLXII.

BRITISH

FOSSIL BRACHIOPODA.

BY

THOMAS DAVIDSON, ESQ., F.R.S., F.G.S.,

MEMBRE ÉTRANGER DE L'INSTITUT DES PROVINCES; OF THE GEOLOGICAL SOCIETY OF FRANCE; LINNEAN SOCIETY OF NORMANDY; IMPERIAL MINERALOGICAL SOCIETY OF ST. PETERSBURGH; ROYAL SOCIETY OF LIEGE; ZOOLOGICAL SOCIETY OF VIENNA; GEOLOGICAL SOCIETY OF GLASGOW; ACADEMY OF SCIENCES OF ST. LOUIS, AMERICA; PALÆONTOGRAPHICAL SOCIETY OF BELGIUM, ETC.

VOL. II.

PERMIAN AND CARBONIFEROUS SPECIES.

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THE

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A MONOGRAPH

OF

BRITISH

CARBONIFEROUS BRACHIOPODA.

BY

THOMAS DAVIDSON, F.R.S., F.G.S.,

ETC.

PART V.

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TO

SIR RODERICK IMPEY MURCHISON, K.C.B., G.C.St.S., D.C.L., LL.D.,

M.A., F.R.S., F.L.S., F.G.S., PRES. R.G.S., ETC.

DIRECTOR-GENERAL OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM; A TRUSTEE OF THE BRITISH AND HUNTERIAN MUSEUMS, OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, ETC., ETC.

My dear Sir Roderick,

In 1849, I undertook to prepare for the Palæontographical Society a series of Monographs to correspond with the seven great divisions in geology. I had then but a very imperfect idea of the magnitude and difficulty of the undertaking. It was at that time believed that the proposed work would occupy one volume, and that it might be completed in the course of four or five years; but I soon found that to attain even an approximate knowledge of the numerous species, and of the correct determination of their localities, it would require geological as well as palæontological researches to be made over nearly the whole extent of the British Islands. This portion of the undertaking would have proved an insurmountable difficulty but for the valuable assistance afforded me by the publication of your admirable 'Silurian System,' and its follower, 'Siluria.' Through the means of which, assisted by the works of other eminent geologists, I have been enabled to determine their proper positions in the respective formations of the numerous species with which I have become acquainted in the course of my researches. To whom, therefore, can I dedicate with greater propriety the second and third volumes of my work, containing the Silurian, Devonian, Carboniferous and Permian species, than to you who have so ably and completely extricated the Palæozoic rocks and fossils from the confusion in which they were involved, previous to the publication of your luminous and valuable works on those departments of geology.

I have the honour to remain,

My dear Sir Roderick,

With sincere respect and gratitude,

Yours most faithfully,

THOMAS DAVIDSON.

APPENDIX AND CONCLUSION.

Five years have elapsed since I first commenced my researches among the Carboniferous Brachiopoda in connexion with this Monograph, and although the time employed may be thought great, it must be remembered, in justice to the many gentlemen who have so zealously afforded me their valuable assistance, that the country and strata has during that interval been continually searched in order to obtain every specimen that might tend to complete the history of our species.

During this lengthened investigation, a vast number of specimens have turned up, and been attentively studied, so that it will be necessary in these supplementary pages to propose some few alterations to the published portions of the work, as well as to add further observations and new species which, having become subsequently known, could not be included in the regular succession of described species.

At the time I commenced my researches, about 260 so-termed British carboniferous species of Brachiopoda had been recorded by different palæontologists, but after a most searching investigation, I could not conscientiously admit more than about 100 of these, and in order to arrive at such a reduction, no small labour was required, nor was I unmindful of the danger Palæontologists should guard against in the breaking down of species, which if injudiciously done, would be as great an evil as that of uselessly multiplying them.[1]

[1] It may be as well to mention that in the second and improved edition of Prof. Morris's 'Catalogue,' published in 1854, 193 species are recorded, but of these about 93 only are retained on my lists.

In 1836, Prof. Phillips enumerated 100 species as having been found in England, of which about 52 are retained.

In his 'Synopsis of the Carboniferous Fossils of Ireland,' published in 1844, Prof. M'Coy described 230 so-termed species of Carboniferous Brachiopoda stated to have been found in Ireland, but he figured only 62. Of the 230, not more than 70 appear to me good species, about 61 are *Devonian* or *Silurian* names not known or *proved* to have been found in true Irish carboniferous strata, and about 117 are either synonyms, or are due to incorrect determinations.

In his memoir 'On the Localities of Fossils of the Carboniferous Limestone of Ireland,' Mr. Kelly enumerates no less than 240 so-termed Irish species! the catalogue comprising the 230 described in the 'Synopsis,' and some others from Portlock's 'Report on the Geology of Londonderry, &c.;' and if we add a few more subsequently discovered, about 250 species! would be put down to Ireland, while my most

Before proceeding further it may be as well that we should inquire into what has led to this extraordinary multiplying of species? Has it not been caused by the uncertainty and difference in opinion that exists among naturalists with reference to what should constitute *genera* and *species,* as well as by the ignorance and precipitation with which we are so often apt to consider new, what may not be known to us?

Deshayes in his paper on the distribution of Acephalous Mollusca in the tertiary basin of Paris, observes:—"For us the *genus* is a creation of our own mind very happily conceived, so as to favour the grouping of those beings which have between them the largest number of common characters, than with any of those which are after them the most nearly related. That is a natural system, and consequently rational one; the genera represent equal degrees, and of comparable organization. That it is while, considering them in this manner, that in our actual researches they acquire the most interest. The fundamental basis of natural history, reposing on the exact and profound knowledge of the *species,* being that which emanates directly from the hands of the Creator, while the art of grouping those which we have recognised is human." Darwin considers the term species, on the contrary, as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other; and that it does not effectually differ from the term variety, which is given to its less distinct and more fluctuating forms. That the term variety, again, in comparison with mere differential differences, is also applied arbitrarily and for convenience sake; that no one can draw any clear distinction between individual differences and slight varieties, or between more plainly marked varieties and sub-species and species.

strenuous efforts have not shown the existence of more than about 80. Mr. Kelly, whose knowledge of Irish geology is equal to that of any other man, and who has visited almost every Irish fossiliferous locality, expresses himself averse to my rejecting so many Devonian and Silurian species said to have been found in his carboniferous strata and localities, but I may again, without hesitation, assert that the larger number, at any rate, are due to incorrect identification, for the examination of many of the original specimens in Sir Richard Griffiths' and other collections have convinced Prof. de Koninck, Mr. Salter, and myself of this important fact.

Mr. Kelly has, however, informed me by letter that a large portion of the doubtful fossils were got in localities of the calciferous slate, a band which lies under the limestone; that out of about 70 not proved to me, because I have not seen specimens, 22 were obtained at Lisnapaste and Donegal; that in these localities there is a great variety, and that they occur in black soft shale, as soft and as easily decomposed by exposure to the atmosphere as any that occurs in the coal-measures: that a lump of this black shale exposed to sun and rain for one summer, would slake or fall to pieces: and he therefore supposes that by far the larger number of Lisnapaste specimens that were originally in Sir R. Griffiths' collection were lost by their removal to the Great Exhibition held in Dublin in 1852, as those tender shales would not bear the agitation of carriage, and consequently mouldered away into very small fragments. That there are six or eight other localities in the calciferous slate in which similar shales occur with fossils, and that he finds, upon looking over his lists, that most of the Devonian species I object to were obtained in those localities. Along with Lisnapaste there is Larganmore, Bruckless, Kildress (the red shales near Cookstown in the old red series), Bundoran, Malahide, Curragh, &c.

It is quite certain that too little attention is given to the many modifications of which a species is susceptible; this fact has been clearly demonstrated by Dr. Carpenter in his admirable researches among the Foraminifera, and will be easily exemplified by the Brachiopoda, which are traceable through the entire series of fossiliferous rocks.

Two opinions appear to prevail at the present time on the origin of species. The greater number of naturalists believe in the creation of separate forms or species capable of producing varieties, but to how great an extent he who made them only knows. Darwin, on the contrary, supposes all species to have been derived from a common progenitor, but to be able to positively admit or refute such an idea, it would be necessary to possess a far more extended and minute knowledge of species, and the causes of their variation, than we at present possess; and although I could not conscientiously go the full length with Darwin, I heartily concur with Prof. Huxley, while observing that "all competent naturalists and physiologists, whatever their opinions as to the ultimate fate of the doctrines put forth, acknowledge that the work in which they are embodied is a solid contribution to knowledge." I will not therefore follow those, who blindly admit the theory, nor concur with those who unhesitatingly pronounce it a chimera, but will do my utmost to register the great facts as they stand, with such comment as I can give, and we may thus be led by degrees to a better understanding of many problems relating to species and their origin than we at present possess. Palæontologists should, above all, be zoologists, and as zoologists have little to do with geological divisions or systems; when they have to inquire into the resemblances and variations in species they should always endeavour to trace a species through its many modifications as far back as they can, or, in other words, to search for its probable progenitor, be it located in the Carboniferous, Devonian, Silurian, or in any other system of strata, as well as to follow or trace its recurrence in more recent periods, and I may boldly assert that when our knowledge of the Brachiopoda shall have extended, that the intimate connexion of many of the so-termed species will be discovered, and that a large proportion of them will be traced through their various modifications to a parent form in stages far more ancient than we are in many cases disposed to admit.

Before concluding, let me therefore recapitulate the result of five years' attentive study of the British Carboniferous species, and point out, however imperfectly, as far as our means will permit, those points which appear to have been clearly made out, as well as some of those I am necessarily compelled to leave unsettled, for I am far from believing that we have arrived at finite or satisfactory results, with reference to several of the species.

Terebratula (pp. 11—18). Plate I and XLIX.

In 1857 I described *T. hastata, T. sacculus, T. Gillingensis,* and *T. vesicularis,* as distinct species, but the subsequent study of a very considerable number of specimens of

each of the above-named forms, has shown so many intermediate shapes, that it must remain a question whether the last three are in reality more than varieties or simple modifications of the first in shape.

At page 12 I mentioned that Mr. De Verneuil, and several other experienced palæontologists, were of opinion that *T. sacculus* was only a variety of *T. hastata;* I also stated (p. 17) that *T. Gillingensis* had been supposed by some observers to be a variation in form or the young of *T. hastata*, and while describing *T. vesicularis* (p. 16), I did not omit to remind the reader that De Koninck's species was extremely variable both in shape and character, so much so, that, to my eyes, certain examples did appear undistinguishable from others of Martin's *T. sacculus*, and to which, Prof. De Koninck admits his shell to be very closely related. No one will, therefore, feel much surprised when I affirm that it is impossible to determine whether very many intermediate shapes or specimens should be referred more to one than another of the four above-named so-termed species, and that there is absolutely no line of demarcation between any of the four forms above recorded.

It would therefore not be surprising, if all the British Carboniferous Terebratulæ hitherto discovered, were to prove mere modifications of a single very variable species, capable of assuming different shapes (influenced no doubt from local circumstances), and not presenting a greater extent of modification than what is common to many other species. For example, is not *Terebratula plicata* and *T. fimbriata* entirely smooth up to a certain age, and indeed often so to an advanced stage, when they afterwards suddenly or by degrees become more or less regularly plicated during the remaining period of their growth? And many other examples could be given of still greater modifications.

T. hastata is the largest British Carboniferous *Terebratula* with which we are at present acquainted, some specimens having attained twenty-six and a half lines in length, nineteen and a half in width, and thirteen in depth (Pl. XLIX, fig. 11), which is certainly the full-grown condition of the species, but which, even under the most favorable conditions, was exceedingly variable, as may be seen by casting a glance at the numerous examples represented in Pl. I and XLIX of the present Monograph.

T. sacculus, in its typical shape, appears to be a thickened dwarfed condition of Sowerby's species, and although it has been urged that Martin's shell was never coloured (so far as known), while *T. hastata* was ornamented with purple-colour bands, it must be also remembered that the number of specimens discovered which have shown these remains of colour have been few; and that we are by no means certain that *T. sacculus* may not have been similarly ornamented. It is likewise not correct to say, that *T. hastata* always possessed sharp edges, for if we examine a large series of specimens we will soon perceive among them *many* as thick edged as any hitherto discovered of the so-termed *T. sacculus*.

If the reader will refer to Pl. VI of my Cretaceous Monograph, he will find therein many modifications of *T. biplicata* carefully represented, and will, I am sure, perceive as great a difference between certain specimens of this cretaceous shell as any he

could produce between *T. hastata* and *T. sacculus.* Look, for example, at the deeply biplicated example (fig. 9) and to that without any biplication at all (fig. 11) of the plate above quoted; still both have been recognised by Palæontologists as belonging to a single species, and to be intimately connected by every degree of modification. I may also, while upon this subject, again remind the reader that out of many thousand specimens of *T. biplicata,* collected near Cambridge, but one (fig. 6) showing remains of colour has been hitherto procured, and whose markings very closely resembled those of our carboniferous *T. hastata.*

T. Gillingensis, in its extreme form (Pl. XLIX, figs. 19, 20), appears different enough from the usual shapes of *T. hastata,* but we must not consider extremes alone, but rather the character presented by the larger number of individuals, and then we will soon find every intermediate shape by which these extremes may be connected with Sowerby's species.

T. vesicularis also, with its deep triundate front, is certainly very peculiar, but this is not the common condition of the generality of specimens, which indubitably by gradation assume the characteristic shapes of *T. sacculus* and *T. hastata.* It is quite evident that in both of the last-named forms there exists at times a tendency to the production of a small central undulation or rib near the front of the dorsal valve, but the frontal margin of the shell may be, and indeed very often is, triundate, without necessitating the production of a median rib. The intimate connexion between *T. hastata* with its straight frontal margin, and the *T. vesicularis* shape with deep triundate or triplicate dorsal valve, or frontal margin, has been furnished by a small limestone quarry at Bowertrapping, near Dalry, in Ayrshire, and of which variety a series of specimens have been carefully represented in Pl. XLIX, figs. 21 to 26. In this locality the *T. vesicularis* shape has attained very large proportions, while in Yorkshire an exactly similar series has been found, but with much smaller proportions; still the Yorkshire *T. vesicularis* is a miniature fac-simile of the large Bowertrapping variety, and in both these cases these extremes merge into the common shape of *T. hastata* or of *T. sacculus.*—As to the other synonyms, I am still of opinion that *T. ficus,* M'Coy (p. 13), should be considered a very convex specimen of *T. hastata,* in which the frontal margin is slightly triundate; and in Pl. I will be found many examples of Sowerby's species with or without a mesial depression in either valve; and this leads me to observe that the Permian *T. elongata* is in all probability, and *T. sufflata* certainly, a recurrent form of *T. hastata* and *T. succulus,* and in proof of which I would beg the reader to cast his eye at Pl. LIV, figs. 1 and 2, 3 and 4, of this Monograph, and he will surely be struck by the close resemblance of the figures of *T. hastata* and *T. elongata* represented therein. The interior details, loops, &c., are exactly similar in all the forms of *Terebratula* here described, and their animal was no doubt so likewise.

One mistaken synonym must, however, be corrected.

At p. 1 *Atrypa virgoides,* M'Coy, was supposed to be a form of *T. hastata,* and to this species is certainly referable the *Seminula virgoides* represented at Pl. 3^{D,} fig. 23, of M'Coy's 'British Palæozoic Fossils,' but the true *Atrypa virgoides,* described and figured in

1844 in the 'Synopsis of the Carboniferous Fossils of Ireland,' Pl. xxii, fig. 21, is nothing more or less than an elongated malformation of *Athyris plano-sulcata!* a discovery entirely due to my zealous friend Mr. J. Wright, of Cork, who having obtained the typical specimen (formerly in the collection of Dr. Haines), and a number of similar malformations found in the limestone near Cork, has left no possible doubt in the matter. (Pl. LI, 11 and 11^a.)

It is well known that the carboniferous fossils of the South of Ireland are usually much distorted by pressure or cleavage, and that the mere form is of but little specific value; and in illustration of this I have represented four specimens of *T. hastata* found near Cork (Pl. XLIX, figs. 13 to 16) which show what extraordinary modifications the same species may assume under similar circumstances.

It is not in my power at present to say what may have been the parent form from whence all these modifications of *T. hastata* have been derived. We shall probably trace it hereafter in the Devonian or even Silurian periods; but I am also quite aware that the generality of Palæontologists are not yet sufficiently imbued with the absolute necessity of enlarging the circle of variation to be permitted to a species, and will naturally say that "they must totally dissent from my putting such a lot of shells into a single species." I think, therefore, that should Palæontologists hereafter consider it desirable to merge the whole British Carboniferous *Terebratulæ* into *T. hastata* that the varietal designations of *Gillingensis*, *Sacculus*, and *Vesicularis*, might perhaps be retained to denote certain modifications in its shape.

Athyris, or Spirigera.

In external shape the species of this genus approach more to *Terebratula* than to any other genus, and therefore in a good or natural arrangement it should precede *Spirifera*. Nine species of *Athyris* have been provisionally retained from among the many synonyms, while the value of *A. globularis* and *A. squamigera* may still require confirmation; for of both these shells the material at my command has been very scanty: and it is even uncertain whether the identification with *A. squamigera* (de Koninck) be correct.

Athyris ambigua (p. 77). Plate XV, figs. 16—22; and Plate XVII, figs. 11—14.

The muscular impressions of *Athyris* have been represented in *Athyris undata* (a Devonian species), but not in quite so precise a manner as could be desired, as seen on some silicified internal casts of *A. ambigua* from the carboniferous limestone of Bakewell (Derbyshire), in the Museum of Practical Geology, and of which two enlarged illustrations will be found in Pl. XVII of the present Monograph. I have also ascertained (since the publication of my description of this species) that the spiral processes, and their interme-

diate connecting lamellæ are similarly disposed in *Athyris ambigua* to those of *A. pectini fera*, of which we have also given a representation in the same plate.

Athyris subtilita.[1] Plate I, figs. 21, 22; and Plate XVII, figs. 8, 9, 10.

In p. 18 I have described the shell as a *Terebratula*, but in p. 86 located it with *Athyris*, to which genus it belongs.

Athyris lamellosa (p. 79). Plate XVI, fig. 1; Plate XVII, figs. 6, 7; and Plate LI, fig. 14.

When describing this species in p. 79 I had not seen any specimens with its concentric lamelliform expansions completely preserved, and it was only subsequently that Mr. J. Wright discovered several fine examples at Little Island, near Cork (Pl. LI, fig. 14), showing that these expansions were prolonged in some specimens nearly an inch from the surface of the shell, and that they differed from those which adorned the valves of *Athyris plano-sulcata* by being somewhat irregularly plaited, or frill-like, as seen in Pl. LI, fig. 14.

Athyris plano-sulcata (p. 80). Plate XVI, figs. 2—15; and Plate LI, figs. 1—13.

This species appears to have varied considerably, and I have already shown that the original *A. virgoides*, M'Coy, is nothing more than an elongated shape of the present species, distorted from pressure and cleavage.

Athyris Carringtoniana, *Dav.* Plate LII, figs. 18—20.

Sp. Char. Shell transverse, sub-rhomboidal, with rounded extremities; wider than long; valves moderately convex, and about equally deep; hinge line, forming an obtuse angle, the greatest breadth of the shell being along the middle; beak of ventral valve small, slightly incurved; foramen circular, and contiguous to the umbone of the opposite valve; beak ridges sharply defined, leaving between them and the hinge line a narrow flattened space. A shallow longitudinal sinus or furrow extends from the extremity of the beak to the front. In the dorsal valve there exists a moderately elevated mesial fold, longitudinally divided by a shallow furrow. Externally both valves are regularly traversed by continuous concentric small ridges or striæ. Dimensions variable: two specimens have measured—

Length 8, width 14, depth 6 lines.
„ 4, „ 7, „ 2 „

[1] The reference is not quite correctly given at p. 86, it should be Hall, in Howard Stansbury's 'Exploration of the Valley of the Great Salt Lake of Utah,' p. 409, pl. 2, figs. 1-2: 1852.

Obs. This interesting species has much resemblance to Phillips' Devonian *Spirifera phalæna*,[1] as well as to De Verneuil's *Terebratula Hispanica* from the Devonian rocks of Spain,[2] and for some time I felt disposed to consider the form under description as a variety of Phillips' species, but after comparing three examples of our carboniferous shell with the figures of the Devonian species, it appeared to me that our shell was more sub-rhomboidal in shape, and had not the straight hinge line of the Devonian species; the sinus in *S. phalæna* and *T. Hispanica* is also much wider and deeper than what we find in our shell, and the mesial fold is also much more deeply divided. I have therefore named the carboniferous species after its discoverer, and as an appreciation of the valuable assistance I have received from him during my examination of the many Staffordshire species he had so zealously collected. Mr. Carrington has obtained eight or nine specimens from the carboniferous limestone of Wetton, in Staffordshire.

RETZIA.

Two species have been already described, and a third has recently been found.

RETZIA RADIALIS (p. 87). Plate XVII, figs. 19—21, and Plate LI, figs. 4—9.

This shell appears to have varied considerably in shape, as well as in the number and size of its ribs, so much so that many of its variations when viewed individually, might lead us to doubt their being simple modifications of Phillips' type. After having assembled a great many specimens from the same as well as from distinct localities, I soon perceived that extreme forms, with twenty-three small ribs, and those with eleven large angular ones upon each valve, could be easily connected by intermediate links; that, for instance, some examples possessed thirteen ribs, others seventeen, nineteen, and twenty-one. In some localities, likewise, owing no doubt to peculiar circumstances, the shells were all small, while in other places they have attained half an inch in length. In Pl. LI, as well as in Pl. XVII, will be found illustrations of all the most marked variations in form hitherto observed.

RETZIA ULOTRIX (p. 88). Plate XVIII, figs. 14, 15.

This appears to be a rare species; a very perfect example has, however, been recently discovered by Mr. Carrington in the carboniferous limestone of Allstonefield, in Staffordshire. (Pl. LIV, fig. 45.)

[1] Figures and descriptions of the Palæozoic fossils of Cornwall, Devon, and West Somerset, p. 71, pl. xxviii, fig. 123, found at Hope, near Torquay. *S. phalæna* belongs to the genus *Athyris*, not Spirifera.

[2] 'Bulletin de la Soc. Geol. de France,' 2d serie, Tom. 2d, p. 463, pl. xiv, fig. 7. Mr. de Verneuil's *T. Hispanica*, belongs to the genus *Athyris*, and is perhaps a synonym of *A. phalæna*.

RETZIA ? CARBONARIA, *Dav.* Plate LI, fig. 3.

Spec. Char. Shell ovate, longer than wide; valves moderately and equally convex, without fold or sinus, margin of valves nearly straight; beak moderately produced, incurved and truncated by a circular foramen, slightly separated from the hinge-line by a small deltidium. Surface marked with about twenty-four small rounded ribs; shell structure minutely punctured. Interior unknown.

Length $9\frac{1}{2}$, width $7\frac{1}{2}$, depth $5\frac{1}{2}$ lines.

Obs. A single example of this interesting species only has been hitherto discovered, and it was not until after much research and hesitation that I venture to apply to it a new specific denomination. Prof. De Koninck, to whom I submitted drawings, pronounced it quite distinct from *Retzia serpentina,* in which the striæ are much more numerous. At one time I thought it might perhaps be referred to *Terebratula Marcyi*, of Shumard ('Palæontology of the Red River of Louisiana,' Pl. I, figs. 4 and 6), as the description given of that shell by the American author, so nearly agreed with that of our British fossil, but having forwarded drawings of our specimen to Prof. Hall, that distinguished palæontologist seemed inclined to consider the English shell as belonging to a more robust species with smaller beak and fewer ribs, and that it differs likewise from *Retzia vera,* in several particulars.

Some uncertainty as to the genus to which it belongs must naturally prevail, since we are unacquainted with its interior dispositions. I am also undecided whether it belongs to *Retzia* or to Prof. Hall's sub-genus *Rhynchospira*,[1] proposed for several shells which bear a close resemblance both in general form and in the interior spires to *Retzia;* but of which the dorsal valve never presents the straight extended hinge-line, nor the ventral valve the short area common to all true species of that genus.

I am indebted to my friend Mr. Salter for the first knowledge of this new British fossil, which was obtained from the lower Carboniferous Shales of Skrinkle, Pembrokeshire, and which is now preserved in the Museum of Practical Geology.

SPIRIFERA.—Since describing the *Spirifers*, many more specimens and observations have been gradually assembled, which will necessitate the introduction of some alterations and additions to what has been written upon the subject. Thirty-seven species are described in pages 19 to 76 of our Monograph, but it must be remembered that some of these were at the time doubtfully and provisionally retained from want of sufficient grounds for rejection or adoption, and that it was only during the interval that uncertainty has been dispelled in certain cases, while a few species that had been supposed distinct subsequently proved to be varieties of some of the others. In the following list a point of

[1] 'Twelfth Annual Report of the Regents of the University of the State of New York,' No. 185, p. 29, 1859.

interrogation is placed before those names, of which the specific claims are still uncertain, and a few synonyms have been appended.

1. Spirifera striata, *Martin.* Sp. = *T. spirifera,* Val. apud Lamarck = *S. attenuata,* Sow. = *S. Princeps,* M'Coy.
? 2. — Mosquensis, *Fischer.* = *C. Sowerbyi* and *C. Kleinii,* Fischer = *S. choristites,* V. Buch.
3. — duplicicosta, *Phillips.* = ? var. *S. humerosa,* Phil.
4. — trigonalis, *Martin,* Sp. = *Sp. bisulcata,* Sow.; = *S. semicircularis,* Phillips; *S. calcarata,* M'Coy (not Sow.); = *S. grandicostata, S. planicosta,* and *S. transiens,* M'Coy; = *S. crassa,* De Koninck; = ? *S. clatharata,* M'Coy.
5. — convoluta, *Phillips.*
6. — triangularis, *Martin,* Sp.
? 7. — fusiformis, *Phillips.* Very doubtful species.
8. — rhomboidea, *Phillips.*
9. — acuta, *Martin,* Sp.
10. — planata, *Phillips.*
11. — cuspidata, *Martin,* Sp.
? 12. — Subconica, *Martin.*
13. — distans, *Sow.* = *Sp. bicarinata,* M'Coy.
? 14. — mesogonia, M'Coy.
15. — pinguis, *Sow.* = *S. rotundatus,* Sow. (not Martin); = *S. sub-rotundatus,* M'Coy.
16. — ovalis, *Phil.* = *S. exarata,* Fleming; = *S. hemispherica,* M'Coy.
17. — integricosta, *Phil.* = ? *A. rotundatus,* Martin (not Sow.) = ? *Sp. paucicosta,* M'Coy.
18. — triradialis, *Phil.* = *Sp. trisulcosa* and *Sp. sex-radialis,* Phillips.
? 19. — Reedii, *Dav.* A very doubtful so-termed species, which will probably have to be suppressed.
20 — glabra, *Martin.* Sp. = *S. oblatus* and *S. obtusus,* Sow.; = *S. linguifera, S. symmetrica,* and *S. decora,* Phillips; = *S. rhomboidalis,* M'Coy.
21. — Carlukiensis, *Dav.*
22. — Urii, *Fleming.*
23. — lineata, *Martin,* Sp. = *S. mesoloba,* Phillips; = *S. imbricata,* Sow., *S. reticulata,* and = *S. strigocephaloides,* M'Coy; = *S. Martini,* Fleming.
? 24. — elliptica, *Phillips.*

25. Spiriferina laminosa, *M'Coy,* Sp. = *S. tricornis,* De Kon.
26. — cristata, *Schloth.* Var. *octoplicata,* Sow. = *S. partita,* Portlock, and var. *biplicata,* Dav.
? 27. — minima, *Sow.* Doubtful species.
28. — insculpta, *Phil.* = *S. quinqueloba,* M'Coy.

29. Cyrtina septosa, *Phillips,* Sp.
? 30. — dorsata, *M'Coy.*
31. — carbonaria, *M'Coy.*

From this list it will be seen that not more than about twenty-three or four species of *Spirifera* have been satisfactorily determined, *S. elliptica, S. mesogonia, Sp. fusiformis, Sp. Reedii, Sp. minima,* and *S. subconica, S. mosquensis, C. dorsata* being probably to some extent synonyms or varieties, and not sufficiently studied from want of sufficient material. I will now add a few remarks with reference to some of the species.

SPIRIFERA STRIATA, *Martin* (p. 19). Plate II, figs. 12—21, and figs. 9—11. Referred to *S. duplicicosta,* and probably the young of *S. striata;* Plate III, figs. 2—6, and Plate LII, figs. 1, 2.

This is a very variable species, the shell is generally transverse, but sometimes it is longer than wide; and I am therefore not quite certain whether the specimens referred to *Sp. Mosquensis* do in reality belong to the Russian type. For instance, the specimen, Pl. LI, fig. 1, is certainly *Sp. striata,* and it will remain a question for future determination whether the specimens, Pl. IV, figs. 13, 14; and Pl. XIII, fig. 16, do really belong to *Sp. Mosquensis.* Mr. J. Wright is of opinion that the so-termed *Sp. clatharata,* M'Coy (p. 21, Pl. III, fig. 6) should be considered a synonym of *Sp. bisulcata* rather than of *Sp. striata* (although in 1855 so referred by Prof. M'Coy), for the description and figure in the 'Synopsis' agrees very closely with some of the finely-ribbed varieties of *Sp. bisulcata,* and that shell M'Coy describes in p. 120 of the last-named work, "with three or four ribs on the mesial fold." It appears evident, likewise, that *Sp. striata,* as described in the 'Synopsis,' includes both *Sp. striata* and the larger forms of *Sp. bisulcata; Sp. bisulcata* of the same author refers only to the young of that species.

SPIRIFERA DUPLICICOSTA, *Phillips* (p. 24). Plate III, figs. 3, 4, (?) 5—11. Plate V, figs. 35, 37, incorrectly referred to *S. trigonalis,* Plate LII, fig. 6.

This very variable species is sometimes with difficulty, and even uncertainty, distinguishable from certain shapes of *Sp. striata.* Mr. Burrow is of opinion that *Sp. humerosa,* Phillips, (p. 23 Pl. IV, figs. 15, 16), should be considered a thickened ponderous local variation of *S. duplicicosta;* and although I was at one time disposed to view it as distinct, am now more inclined to follow Mr. Burrow by placing it among the varieties of the last-named species. The mesial fold in *S. duplicicosta* is sometimes much prolonged beyond the level of the lateral portions of the valves, as seen in Pl. V, fig. 35, and Pl. LII, fig. 6; and it is even sometimes difficult to distinguish certain examples of *S. duplicicosta* from *S. striata.*

Spirifera trigonalis, *Martin.*

At one time I erroneously believed, with the generality of Palæontologists, that *Sp. trigonalis,* Martin, p. 29; *Sp. bisulcata,* Sow., p. 31; *Sp. crassa,* de Kon., p. 25; *Sp. grandicostata,* M'Coy, p. 23; and *Sp. transiens,* M'Coy, p. 33, were sufficiently distinct to be retained as separate species; but a subsequent examination of a more extensive series of specimens has led me to infer that they are all modifications of a single very variable species, for which the term *trigonalis,* or *bisulcata,* should be retained; and I am glad to say that this opinion has been already accepted by several experienced observers. No species is more variable in its general aspect, or in the number of its ribs, still every intermediate form may be found in our carboniferous limestone districts. To attempt, therefore, to describe all these variations would be endless; but the following figures will convey an idea of its more prevalent shapes. We would therefore refer to *Sp. trigonalis,* Pl. IV, figs. 1, 2; Pl. V, figs. 1, 23, 24, and 38, 39; Pl. VI., figs. 1—22; Pl. VII, figs. 1—4, 7—16; and Pl. L, figs. 3—8; but I am at the same time ready to allow that if, for example, we take the winged more simple form, Pl. L, fig. 7, and then compare it with the transversely oval, rounded, thickened var. *crassa* (Pl. VI, fig. 20), the notion of both being modications of a single species will, to the generality of observers, appear absurd; still if we find every variations connecting these extremes, are we to refuse the evidence of our eyes and senses, and to create as many species as we possess specimens? In many examples of undoubted *Sp. trigonalis* and *S. bisulcata,* the cardinal angles are rounded so that the hinge-line is shorter than the breadth of the shell, but in the larger number of individuals these angles became more or less prolonged, and in some specimens they form long attenuated wings (Pl. L, figs. 3, 5, 6, 7, 8, and 9). In his list of the carboniferous Brachiopoda of Belgium, Prof. de Koninck admits that his *Sp. crassus,* and M'Coy's *Sp. grandicostata* are in all probability varieties of *Sp. bisculata.*[1] In its most simple shape, the sinus of *S. trigonalis* presents three longitudinal ribs, of which the central one is usually the largest (Pl. L, figs. 3 and 7); in other specimens there exists five, or two smaller ones, one on either side of the central rib (fig. 4), while in larger individuals we often find seven ribs, or three on either side of the central one (fig. 9), but in some specimens the ribs are more numerous and less regular in their respective widths. The mesial fold is often composed of three bifurcated ribs, or is divided by two sulci; but here again, although this is certainly the prevalent feature, in some specimens these three ribs are more divided and the fold is sometimes not so sharply bisulcated. The shell of *Sp. trigonalis* is but rarely perfectly preserved, but when so the whole surface or ribs are finely striated and closely imbricated or decussated by numerous transverse fine spinulose or serrated ridges, as many

[1] 'Mémoire sur les genres et les sous-genres des Brachiopodes munis d'appendices spiraux,' par M. Davidson, traduit et augmenté de Notes par le Dr. L. A. Koninck. 'Mémoirs de la Societé Royale de Liege,' 1859.

as from twenty to thirty occupying the width of three lines, and of which an enlarged representation will be found in Pl. L, fig. 9[a].

SPIRIFERA CONVOLUTA, *Phillips* (p. 35). Plate V, figs. 9—15 (2 to 8 excluded); and Plate L, figs. 1, 2.

This appears to be a rare species, of which three or four very remarkable specimens have been found by Mr. J. Rofe, at Thorneley, near Chipping (ten miles N.E. of Preston). One specimen in particular (Pl. L, fig. 1) was perfect from end to end, and measured eleven lines in length by fifty-seven in breadth, and twelve in depth. The shell occurs also in the carboniferous limestone of the neighbourhood of Wetton, in Staffordshire. I fear having too hastily coincided in the view taken by Prof. de Koninck, that *Sp. rhomboidea* (Phillips) was a synonym of *S. convoluta.* Mr. E. Dupont states he has found *S. convoluta* abundantly at Celles, near Dinant, in Belgium.

SPIRIFERA RHOMBOIDEA, *Phillips.* Plate V, figs. 2—8.

Prof. Phillips's description of this species will be found in the foot note of p. 36. A great difference is observable in the mesial fold and sinus of all the specimens I have seen of this and the preceding species. In *Sp. convoluta* it resembles much that of *Sp. trigonalis,* its three principal ribs being strongly marked, while in *Sp. rhomboidea* they are more numerous, and hardly defined.

SPIRIFERA TRIANGULARIS, *Martin* (p. 27). Plate V, figs. 16—24; and Plate L, figs. 10—17.

This is a very elegant and well-characterised species, easily distinguishable, but extremely difficult to extract from the hard limestone matrix in which it is usually imbedded: nevertheless, after much labour, Mr. Burrow has been able to procure a numerous series, among which were several examples that retained their elongated tapering wings quite perfect; but it is remarkable that when one wing became very much prolonged, the other was somewhat suddenly abbreviated, and this is very clearly discernible in the two or three of the most perfect specimens hitherto discovered (Pl. L, figs. 13, 15, 16). It is also necessary to remark, that in young shells the front was not very much produced, while in the adults the acutely angular cuneiform rib in the fold and sinus projects considerably above and beyond the regular surface of the valve (Pl. V, fig. 21).

Spirifera acuta, *Martin.* Plate LII, figs. 6, 7.

Conchyliolithus anomites acutus, *Martin.* Petrificata Derbiensia, pl. 49, figs. 15, 16, 1809.

For a long time I felt much puzzled with reference to this shell, and supposed it the young of some other species. My uncertainty has been, however, recently removed by Mr. Burrow's fortunate discovery of a number of specimens of all ages, and exactly agreeing with Martin's description and figure : "Valves convex semicircular, marked with deep, longitudinal equal striæ ; hinge patulous, straight, but not extending the whole breadth of the shell ; foramen triangular, large ; beak of the perforated valve prominent pointed, incurved ; the other short and obtuse ; margin acutely crenate, and furnished with a large angular sinus, causing a somewhat strong plicature on the surface of the valves ; not frequent ; small ; limestone ; Winster and Croom Hill." None of Mr. Burrow's specimens exceeded the proportions of Martin's figure,—viz., six lines in length by about nine in breadth, each valve in adult individuals possessing from seventeen to nineteen angular ribs, the central one being at the same time the largest and most elevated of the valves. Mr. Burrow obtained his specimens from the carboniferous limestone in the neighbourhood of Settle, where the shell is not very abundant.

Spirifera distans *Sow.* (p. 46). Pl. VIII, figs. 1—17.

To this species I would unite *Sp. bicarinatus* (p. 47, Pl. VIII, fig. 18, and Pl. LII, fig. 4), which Prof. M'Coy established on a single very imperfect specimen from Cork, in Ireland. This specimen, now in the possession of Mr. J. Wright, of Cork, has quite the appearance assumed by certain examples of *Sp. distans*, of which it is, in all probability, a synonym. Prof. de Koninck, in his list of the Carboniferous Brachiopoda of Belgium, published in 1859, places M'Coy's *Sp. bicarinatus* among the synonyms of his *Sp. Roemerianus*, but this, I fear, is a mistake, for the original specimens of both would not lead me to a similar conclusion.

Spirifera cuspidata, *Martin* (p. 44). Plate VIII, figs. 19—24 ; Plate IX, figs. 1, 2.

Prof. de Koninck, myself, and others, have been led to suppose Martin's *Anomites subconicus* (p. 48, Pl. IX, fig. 3) to be a synonym of *Sp. cuspidatus*. I am, however, doubtful as to this being a correct opinion, from the fact that on perfectly preserved examples of Martin's *A. subconica*, of which Pl. LII, fig. 4, is an illustration, the entire surface of the ribs and shell (area excepted) are regularly traversed by continuous equidistant, sharp projecting laminæ, exactly similar to those which cover the

surface of *Sp. laminosa ;* indeed, some examples of this last shell so closely resemble several Derbyshire specimen of *Sp. subconica* as to have puzzled me extremely, and to have almost made me consider both it and M'Coy's species as synonymous. Again, other examples of *Sp. laminosa* have so narrow an area as to differ much from Martin's shell. The ribs also in *Sp. subconica* appear relatively stronger and less numerous than in the generality of specimens of *Sp. cuspidata.* I therefore for the present, and until the question can be definitely settled by the discovery of a larger number of Derbyshire specimens of *S. subconica,* prefer to retain this last (as I have done in p. 48 of the present Monograph) as a distinct species. It is unfortunately very rare to find specimens of *Sp. cuspidatus* with the shells preserved, so that we are still uncertain whether its external sculpture was similar to that of *Sp. subconica ?*

Spirifera glabra, *Martin* (p. 59). Plate XI, figs. 1—9 ; and Plate XII, figs. 1—12.

This is an excellent but most variable species, or a type round which are clustered many modifications not sufficiently marked to constitute separate species; for although the typical form of *Sp. glabra* possesses smooth valves, it is not uncommon to find in other and exceptional examples faint indications of lateral plication, obscurely flattened, or slightly rounded ribs ; the fold and sinus remaining always smooth. These modifications lead us gradually to such forms as *Sp. rhomboidalis,* M'Coy, (p. 57, Pl. XII, figs. 6, 7), which are likewise in all probability mere modifications of *Sp. glabra.*

Spirifera lineata, *Martin* (p. 62), Plate XIII, figs. 4—13 ; and Plate LI, fig. 15.

When describing *Sp. lineata,* at p. 62, I had not seen any examples in which the shell was perfectly preserved, but the subsequent discovery of several excellent specimens in Scotland, as well as in India and America, has shown that externally the surface was covered with numerous concentric ridges, rarely in any place more than a line apart, but usually very much closer, and from each of which projected numerous, closely-packed spines, which thus formed a series of spiny fringes overlaying each other all over the shell. When the spines were absent, which is the general condition in which the shell is found, the surface appears marked by numerous and regularly imbricated lines, the radiating ones being produced by the small elevations from which each spine took its rise, as I have attempted to show in the enlarged figure in Pl. LI, which is very different from the irregular manner in which the spines are scattered over the surface of *Sp. Urii,* of which Pl. LI, fig. 16, is an illustration.

Spirifera ellipitica, *Phillips* (p. 63). Figs. 1—3.

I am not quite satisfied of having been correct while placing this species? among the varieties of *S. lineata,* its general transverse form being very constant, as far as I have hitherto seen.

Spiriferina cristata, *Schlotheim*, var. *octoplicata Sow.* (p. 38). Plate VII, figs. 37—47, and 60, 61; and Plate LII, figs. 9, 10, and 13.

This is certainly a very variable species. In the generality of specimens the mesial fold is composed of a single rib, which is much larger than those situated on the lateral portions of the shell; its crest is sometimes evenly rounded in all its length, but, as I have already described, becomes in many cases flattened, and even slightly longitudinally depressed as it approaches the frontal margin. Subsequently to my description of this interesting species, I became completely satisfied that *S. partita,* Portlock (p. 41, Pl. VII, figs. 60, 61) would require to be located among the synonyms of the species under description, and another remarkable modification has turned up, which I have distinguished by the varietal designation of *biplicata* (Pl. LII, figs. 11, 12). This variety, of which many examples have been found by Mr. Burrow in the lower scar limestone of Settle, in Yorkshire, and by Prof. Harkness in that of Little Island, near Cork, in Ireland, has the usual shape and character of *Sp. cristata,* or of its large carboniferous variety *octoplicata;* it presents also, according to the specimens, the same variable number of lateral ribs, viz., four, five, and eight, on the lateral portions of the shell, but the fold is no longer simply rounded or flattened, as in the typical shapes of *Sp. cristata,* but divided into two distinct ribs by a sulcus of variable depth; a well-marked rib extending likewise along the middle of the sinus, as seen in the illustrations above mentioned. That this is nothing more than a modification of the more general shape of Schlotheim's species is clearly proved by the many intermediate gradations in form which connect the specimens with rounded sinus to those with biplicated ones. In Pl. LII, fig. 9 represents a specimen of *Sp. cristata* with a more than usual angular fold; fig. 10 shows the fold slightly flattened along its crest, and divided by a slight groove, while in figs. 11 and 12 it is so much deepened as to divide the fold into two ribs. Very rarely indeed, but still as an exception, the fold has become triplicated towards the front, a fact which was not overlooked by Sowerby, since a specimen so conditioned is figured by that author along with his type-shapes of *Sp. octoplicata,* Pl. LII, fig. 13. The largest example of the var. *biplicata* that has come under my notice measured—

Length 12, width 15, depth 9 lines.

Cyrtina septosa, *Phillips* (p. 68). Plate XIV, figs. 1—10; Plate XV, figs. 1, 2; and Plate LI, fig. 17.

When publishing my description and figures of this interesting species I expressed a regret that all my efforts had proved ineffectual in making out the interior characters of the dorsal valve. Since then, thanks to the continued and zealous exertions of my indefatigable friend Mr. Burrow, the internal cast of the dorsal valve was discovered (Pl. LI, fig. 17), showing that the muscular impressions (anterior and posterior divisions of the adductor or occlusor muscle) were similarly arranged to those of *Spirifera*, and that there does not exist in that valve any septa, as in *Pentamerus*, a fact I also mentioned while describing M'Coy's so-termed *Pentamerus carbonarius*.

Rhynchonella (pp. 89—112).

Eight or nine species have been provisionally retained; but the claims of *Rh. cordiformis* have not been satisfactorily established, and of *Rh.* (?) *gregaria*, but two imperfect valves have come under my examination. *Rhynchonella trilatera* is a rare shell, but several specimens have been recently found by Mr. Burrow near Settle, in Yorkshire, and some others by Mr. Carrington in the Limestone of Wetton, in Staffordshire. *Rh.* (?) *nana*, and *R. semisulcata* are at present by far too doubtful to deserve more than a passing notice. When describing and illustrating *Rh. pleurodon*, I was much puzzled with a large Rhynchonella (Pl. XXIII, fig. 22), which appeared to me to differ from the last-named shell in several particulars, and which I then doubtfully and provisionally left under *R. pleurodon.*

Rhynchonella (?) Carringtoniana, *Dav.* Plate XXIII, fig. 22; and Plate LIII, figs. 1, 2.

Sp. Char. Shell transversely oval, valves almost equally deep. Dorsal valve convex, with a broad mesial fold apparent only on the anterior half of the shell, where it is rarely very much elevated. About thirty-two or thirty-four radiating, rounded, simple ribs ornament this valve, of which from six to seven occupy the fold. Ventral valve longitudinally divided by a broad sinus, and marked with about the same number of ribs as in the opposite valve. Beak small and incurved; dimensions variable.

Length 15, breadth 19, depth 11 lines.

Obs. While illustrating *Rh. pleurodon* in Pl. XXIII of the present Monograph, I received from Mr. Parker, of Manchester, the loan of a large shell, fig. 22 of the same plate, which he had obtained from the Carboniferous Limestone of Twiston, in Lancashire. This shell appeared to differ so much from the many specimens of *R. pleurodon*, in my possession, that I did not venture to refer it positively to any known species. Since

30

that period, several more similar specimens having been discovered by Mr. Carrington in the Carboniferous Limestone of Wetton, in Staffordshire, I have refigured the species, and have distinguished it by a separate denomination. When placing adult specimens of the shell under description in the same tray along with full-grown examples of *Rh. pleurodon*, both appeared clearly distinguishable, but the distinction between it and certain specimens of the Permian *Camarophoria Humbletonensis*, Howse, was not quite so apparent.[1] *Rh.* (?) *Carringtoniana* is more regularly transversely oval than *Rh. pleurodon*; the valves are more evenly convex; the ribs on the fold are not deflected so as to meet the corresponding margin of the opposite valve, as is the case with the last-named species. The ribs of *Rh. Carringtoniana* are also more rounded, and those on the lateral portions of the ventral valve regularly arched, and not straight, with their extremities bent upwards as in *Rh. pleurodon*. None of the ribs of *Rh. Carringtoniana* are longitudinally grooved near their extremities, as is the case with Phillips's species. When quite young, and up to a certain age, *Rh. Carringtoniana* is very slightly convex, and without any defined mesial fold.

Camarophoria (pp 113—118).

Four species have been recorded, but more abundant and better materials, with reference to *C. isorhyncha* and *C. lateralis*, must be obtained before these so-termed species can be definitely admitted. Of the first, I am acquainted with but a single imperfect Irish example, now in the possession of Sir R. Griffiths; of the second, with those only in the Cambridge Museum. *C. crumena* is a well made out species, and certainly the same as that from the Permian rocks, known under the designation of *C. Schlotheimi*. Nothing definite can be said with reference to *Camarophoria* (?) *proava*, which is, probably, a variation of *C. crumena*.

Strophomena analoga (pp. 119—123). Pl. XXVIII, figs. 1—13.

With small modifications, in detail, this species appears to have been recurrent from the Silurian and Devonian periods; the term *analoga* may be retained for the Carboniferous variety.

Streptorhynchus Crenistria (p. 124).

I can add but little to what I have already said with reference to this species and its varieties; but some very interesting interiors of the dorsal valve, found by Mr. Burrow

[1] It is at times difficult to determine, from exteriors only, whether a shell belongs to *Rhynchonella* or to *Camarophoria*, and this is the case with the three or four examples of *R. Carringtoniana* I have been able to examine.

near Settle, in Yorkshire, are deserving of notice. In these specimens (Pl. LIII, fig. 3), the adductor or *anterior occlusor* scars of Hancock (A) are longitudinally striated, while the *posterior occlusors* (A′) are clearly defined and dendritic in their markings.

Orthis (pp. 129—135).

I can add nothing to what has been already said with reference to the species composing this genus, except that *Orthis* (?) *antiquata* must still remain among the doubtful so-termed species, for only one or two specimens of it have been hitherto found.

Productus (pp. 135—179).

Twenty-eight species? and a few named varieties have been here described; but, subsequently, five more new to England were discovered by Mr. Burrow in the Carboniferous Limestone of Settle, which we will at once proceed to describe.

Productus marginalis, *De Koninck* (Pl. LIII, fig. 3).

Productus marginalis, *De Koninck.* Monographie du genre Productus, pl. xiv, fig. 7, 1847.

Sp. Char. Shell thin, circular, or sub-trapezoidal; slightly wider than long, somewhat geniculated and gibbous, with a narrow, projecting, curved margin; hinge-line rather less than the greatest width of the shell, with a small rudimentary area; beak small; ears flattened; surface wrinkled over the visceral portion of the shell, and irregularly interrupted, here and there, by prominent tubercules, which give rise to slender spines; while on the anterior portion of the curved margin the wrinkles of the visceral portion are replaced by small contiguous ribs; dorsal valve almost flat, concave only, or suddenly bent close to the margin; surface slightly marked by concentric wrinkles, which are replaced by small ribs near the margin; little pits are likewise dispersed over its surface. Interior muscular and other markings agreeing with those of the generality of Producta. Dimensions variable.

Length 8, width 9 lines.

Obs. The discovery of this Productus, as a British species, is due to Mr. Burrow; and in order to be quite certain as to its identity, the specimen here figured was fowarded to Prof. de Koninck, who confirmed the identification. In England it appears to be a rare species. It was obtained from the Lower Scar Limestone of Settle, in Yorkshire. At Visé, in Belgium, it is not rare in the state of internal casts, four or five specimens only have been found by Prof. de Koninck with the shell completely preserved.

PRODUCTUS KONINCKIANUS, *De Verneuil.* Plate LIII, fig. 7.

PRODUCTUS CANCRINI, *De Koninck.* Descript. des Anim. foss. du Terr. Carb. de Belgique, p. 179, pl. ix, fig. 3, 1843 (not of De Verneuil and De Keyserling).
— KONINCKIANUS, *De Verneuil.* Russia and the Ural Mount., vol. ii, pp. 253 and 274, 1845.
— — *De Keyserling.* Reise in das Petschora Land, p. 203, pl. iv, fig. 4, 1846.
— SPINULOSUS, *De Koninck.* Mon. du genre Productus, pl. xi, fig. 2, 1847 (not of Sowerby).

Sp. Char. Shell longer than wide, posteriorly rounded, broadest anteriorly; ventral valve evenly convex, without sinus; beak gibbous, much elevated and incurved, but not overlying the hinge line, which is less than the greatest width of the shell; ears very small, with two or three wrinkles; surface covered with numerous undulating regular, thread-like striæ, which increase from the interpolation of smaller striæ at variable distances from the beak, and which are interrupted at short intervals by small tubercules, disposed pretty regularly in quincunx, and giving rise to slender spines. Ventral valve concave, following the curves of the opposite one. Dimensions variable.

Length 9, width 8 lines.

Obs. This pretty little species has been taken for Sowerby's *P. spinulosus* by Prof. de Koninck, but from which it is completely distinct, Sowerby's shell not being longitudinally striated, as is the case with the form under description. It differs also in shape from *P. spinulosus*, which is usually transverse, while *P. Koninckianus* is generally slightly longer than broad; and, lastly, it differs again by the profile curve presented by the larger or ventral valve. It is also distinct from *Productus Cancrini.* Prof. de Koninck observes that apart from the arrangement of the spines it is a complete miniature of *P. Cora,* and that it is distinguishable from *P. arcuarius* by the absence of the transverse concentric furrow which divides the ventral valve of the last-named shell into two distinct portions.

The discovery of this species in the Lower Scar Limestone of Settle, in Yorkshire, is due to Mr. Burrow, and I am not acquainted with any other British locality. In Belgium it is very rare in the limestone of Visé, and has been found by Count Keyserling in Carboniferous Limestone on the banks of the Soiwa in the Petschora, Russia.

PRODUCTUS UNDIFERUS, *De Koninck.* Plate LIII, figs. 5, 6.

PRODUCTUS SPINULOSUS, *De Koninck.* Descript. des Anim. foss. du Terrain Carb. de Belgique, p. 183 (partim), pl. x, fig. 4, 1843 (not *P. spinulosus,* Sow.).
— UNDIFERUS, *De Koninck.* Monograghie du genre Productus, pl. v, fig. 4, and pl. xi, fig. 5, 1847.

Sp. Char. Shell small, almost circular, about as wide as long; ventral valve gibbous; beak vaulted, but not projecting over the hinge-line, which is about as wide as the greatest breadth of the shell; ears small; dorsal valve concave, following the curves of the opposite one; valves externally marked with regular longitudinal, undulating thread-like striæ, and small more or less defined irregular concentric wrinkles. Delicate spines rise likewise here and there from the surface of the valves, and are more numerous on the ears close to the cardinal edge.

Length 6, width 6 lines.

Obs. Having sent British specimens of this shell to Prof. de Koninck, they were declared to be identical with his *Prod. undiferus.* This small species does not appear to attain the proportions of *P. undatus,* which it most resembles; its ribs appear to be proportionately smaller, and the wrinkles, where these exist, are never so large or regular as in *P. undatus.* Its margin appears also to have been broad and regularly curved in perfectly preserved specimens, as represented in Pl. LIII, fig. 6. This little shell was discovered by Mr. Burrow in the Lower Scar Limestone of Settle, the only British locality at present known. On the continent, it was found by Prof. de Koninck in the Carboniferous Limestone of Visé, as well as in the shales of Tournay, in Belgium.

PRODUCTUS NYSTIANUS, *De Koninck.* Plate LIII, fig. 9.

PRODUCTUS NYSTIANUS, *De Koninck.* Descrip. des Animaux foss. du Ter. Carb. de Belgique, p. 202, pl. vii^{bis} fig. 3; pl. ix, fig. 7, and pl. x, fig. 9. 1843. Also Monographie du genre Productus, pl. vi, fig. 4, and pl. xiv, fig. 5.

Sp. Char. Shell rather small; hinge-line straight, and as wide as the greatest width of the shell; ventral valve geniculated, semicircular, and much flattened on the posterior or visceral portion, abruptly bent towards the margin; beak very small, and hardly produced. The visceral portion is marked by numerous more or less regular undulating concentric wrinkles, interrupted here and there by projecting tubercules, while the anterior or bent portion of the valve is ornamented with small longitudinal ribs. A row of curved spines rise from and project over the cardinal edge. Dorsal valve almost flat on the visceral portion, bent near the margin, and ornamented as in the opposite one. Interior unknown.

Length 6, breadth 8 lines.

Obs. Three or four examples of this interesting species, completely agreeing with those represented by Prof. de Koninck in Plate XIV, fig. 5, of his 'Monographie,' were discovered for the first time in England by Mr. Burrow, but none of them assumed the tubuliform prolongations represented by my Belgian friend in Pl. VI, fig. 4, of the above-named work. Prof. de Koninck informs us that when adult and fully developed the shell assumes an entirely different aspect, viz., that a portion of the prolongation of the larger or ventral

valve becomes dilated at the sides prior to becoming elongated and transformed into a cylindrical tube; that while this singular modification was being effected the inferior edge became elongated in a perpendicular direction to that of the anterior tube, but in a very irregular manner, and thus producing a second tube whose sides are at the same time irregular, strongly undulated, and ribbed; that these small ribs and undulations are particularly observable on the portion of the tube formed by the prolongation of the cardinal edge. I have never, however, had the advantage of seeing any of these singularly modified specimens, and which must be of very rare occurrence; for the generality of Belgian examples that have come under my notice exactly agree as to shape with those figured by Prof. de Koninck in Plate xiv of his work, as well as to those represented in the present Monograph.

Mr. Burrow found this shell in the Lower Scar Limestone of Settle, in Yorkshire, while Prof. de Koninck's specimens were obtained in the equivalent Limestone of Visé, in Belgium.

PRODUCTUS DESHAYESIANUS, *De Koninck*. Plate LIII, figs. 11, 12.

PRODUCTUS DESHAYESIANUS, *De Koninck*. Descript. des Animaux foss. du Terr. Carb. de Belgique, p. 193, pl. x, fig. 7, 1843; and Mon. du genre Productus, pl. xiv, fig. 4.

Sp. Char. Shell small, semicircular about as wide as long; hinge-line nearly straight, and as wide as the greatest breadth of the shell. Ventral valve regularly arched, and evenly convex; surface marked by minute concentric ridges, from which rise closely-set spiny tubercules, but which become gradually less numerous towards the margin in adult individuals. Dorsal valve concave, following the curves of the ventral one.

Length 3, width $3\frac{1}{2}$ lines.

Obs. Two imperfect specimens only of this small species (?) have been hitherto discovered in England, which, having been forwarded to Prof. de Koninck for identification and comparison, were declared by him to be referable to his Belgian type. Mr. Burrow found his specimens in the Lower Scar Limestone of Settle, in Yorkshire, where the shell appears to be exceedingly rare. Prof. de Koninck procured his specimens from the equivalent Limestone of Visé, in Belgium.

PRODUCTUS STRIATUS (p. 139). Plate XXXIV, figs. 1—5; and Plate LIII, fig. 4.

Since describing this species, a specimen measuring nearly five inches in length by rather more than the same in breadth, has been discovered by Mr. Carrington in the Carboniferous Limestone of Wetton, in Staffordshire. It has also been found in the counties of Dublin, Kerry, and Leitrim, in Ireland.

Productus sinuatus (p. 157). Plate XXXIII, figs. 8—11.

Specimens of this interesting species have been recently found by Mr. Carrington at Wetton, in Staffordshire.

Productus ermineus, *De Koninck* (p. 164). Plate XXXIII, fig. 5.

This rare species (?) has been discovered by Mr. Carrington in the Carboniferous Limestone of Wetton, in Staffordshire.

Productus aculeatus, *Martin* (p. 166). Plate XXXIII, figs. 16—18 (19?), and **Productus Youngianus**, *Dav.* (p. 167). Plate XXXIII, figs. 21—23.

Mr. Burrow is disposed to consider these two species as synonymous, and believes that there exists every possible gradation from the almost perfect smoothness or transverse lines of *aculeatus* to the strong ribs of *Youngianus;* while Messrs. Young, Armstrong, and some others are of a contrary opinion. Mr. Young observes that if there is such a thing as value to be attached to species of the same genus, that there are good distinguishing characters between each of these species; that he has collected a great many specimens of *P. Youngianus* out of the Shale and out of the hard Limestone, where the whole of the finer external markings have been stripped off, and that he has never been able to identify it in this condition with any form of *P. aculeatus* he has ever collected or seen figured; that in all conditions perfect examples show distinctly-marked ribs, and also that these ribs are not due, as has been sometimes supposed, to the prolongation of the basis of the spine, but that they exist independently of the spines; that he has in his collection specimens that have more than their usual complement of spines, which are not so distinctly ribbed as some that have many less spines, showing, as in many other species, that spines had nothing to do with the formation of the ribs, the spines having no regular order of position in the valves, while the ribs, in all the examples that have come under his notice, show a regular order of formation; that, in addition to this peculiar structure, the general form of the shell would be a good guide in distinguishing the two species, *P. aculeatus* being a much rounder shell, with broader ear expansions than *P. Youngianus*, which in all Scotch specimens is much elongated, and with small ear expansions; that on all his best specimens of Martin's shell there is not a trace of ribs, although the lines of growth are preserved, and he can count from eight to twelve distinct scattered spines on each specimen, while on an average-sized specimen of *P. Youngianus* there are as many as seventy to eighty spines. Such are the results of Mr. Young's careful examination of many Scottish specimens; and I must admit that when we look at a tray full of shells agreeing with Martin's type and figure of *P. aculeatus* (Pl. XXXIII, figs. 16, 17, 18, and

20 of our work), and then cast a glance at another *one* of *P. Youngianus* (figs. 21—23), a very great difference is observable between them, fig. 19 belonging, according to Mr. Young, to another species. I am quite disposed to concur with Mr. Young, that in the case of *P. Youngianus* the spines have nothing to do with the formation of the ribs, but I am still uncertain whether in the fully grown or adult condition *P. aculeatus* was not liable to become more or less ribbed towards its margin, for even in *P. Youngianus,* when quite young, no ribs are discernible, but they become apparent with the growth of the shell.

PRODUCTUS SUB-LŒVIS (p. 177). Plate XXXI, figs. 1, 2; Plate XXXII, fig. 1; and Plate LI, figs. 1, 2.

This interesting species has been found by Mr. Wardle in the Carboniferous Limestone of Caldon Low, Staffordshire. One specimen shows a row of spines projecting from a median longitudinal ridge, which extends along the ventral valve, as represented in Pl. LI, fig. 2. The visceral portion of the shell is also sometimes very irregularly wrinkled, although at other times it is comparatively smooth.

CHONETES.

I can add nothing to what has been stated in pages 179—191 of this Monograph. There are, however, a few points which will require further consideration when more ample material shall have been obtained. *C. papilionacea* has sometimes exceeded the dimensions I have given; for there exists in Sharp's collection at the Geological Society a specimen from Kendal which measures six and a half inches in breadth by three in length.

CRANIA AND DISCINA (pp. 192—198).

Nothing new has been found since my descriptions have been written.

LINGULA (pp. 199—210).

ERRATA.

At page 203, line 23, write—1. MUSCLES PRÉADDUCTEURS (*anterior* adductor), &c.

ENGLISH, WELSH, SCOTCH, AND IRISH COUNTIES IN WHICH THE FOLLOWING CARBONIFEROUS BRACHIOPODA HAVE BEEN DISCOVERED.

This Table shows the Shires in which Carboniferous Strata exist, as well as the amount of work done in the way of collecting. Those Counties from which few Species are recorded will, no doubt, upon further exploration, be found to contain some more of the common Species.

GENERA AND SPECIES.

The point of ? denotes that the so-termed species requires further research prior to its being definitely admitted.

England.	Wales.	Scotland.	Ireland.	Abroad.	GENERA AND SPECIES.	ENGLAND. Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
×	×	×	×	×	*Terebratula hastata*, Sow. Min. Con., tab. 446, figs. 1, 2, 3. Dav. Mon., pp. 11 and 213, pl. i, figs. 1—17; and pl. xlix, figs. 11—17 = *T. ficus*, M'Coy	×	×	×	×		×	×	×		×	×				×	×	×
×				×	— var. *Gillingensis*, Dav. Mon., pp. 17 and 213, pl. i, figs. 18—20; pl. xlix, figs. 19, 20	×					×											
×	×	×	×	×	— *sacculus*, Martin. Pet. Derb., tab. xlvi, figs. 1, 2. Dav. Mon., pp. 14 and 213, pl. i, figs. 23—30; pl. xlix, figs. 27—29 = *T. sufflata*, Schlotheim	×	×	×	×		×	×	×		×					×	×	
×		×		×	— *vesicularis*, De Kon. Anim. Foss. Belg., p. 666, pl. lvi, fig. 10. Dav. Mon., p. 15, pl. i, figs. 25, 26, 28, 31, 32; and p. 213, pl. xlix, figs. 26—30	×	×				×											
×	×	×	×	×	*Athyris Royssii*, L'Eveillé. Mém. S. G. France, vol. ii, pl. ii, figs. 18—20. Dav. Mon., p. 84, pl. xviii, figs. 1—11 = *S. glabristria* and *S. fimbriata*, Phil. = *A. depressa*, M'Coy ? = *A. pectinifera*, J. de C. Sow.	×	×	×					×		×	×				×	×	
×					— *expansa*, Phillips. Geol. York., vol. ii, p. 220, pl. x, fig. 18. Dav. Mon., p. 82, pl. xvi, figs. 14, 16—18; pl. xvii, figs. 1—5 = *A. fimbriata*, J. de C. Sow. (not of Phillips)	×	×	×	×						×					×		
×					— *Carringtoniana*, Dav. Mon., p. 217, pl. lii, figs. 18—20										×							
×			×	×	? — *squamigera*, De Kon. Anim. Foss. Belg., p. 667, pl. lvi, fig. 9. Dav. Mon., p. 83, pl. xviii, figs. 12, 13		×															
×			×	×	— *lamellosa*, L'Eveillé. Mém. S. G. Fr., vol. ii, pl. ii, figs. 21—23. Dav. Mon., pp. 79 and 217, pl. xvi, fig. 1; pl. xvii, fig. 6; and pl. li, fig. 14 = *S. squamosa*, Phil.	×	×	×	×						×							
×		×	×	×	— *plano-sulcata*, Phillips. Geol. York., vol. ii, p. 220, pl. x, fig. 15. Dav. Mon., pp. 80 and 217, pl. xvi, figs. 2—13, 15; and pl. li, figs. 11—13 = *A. de Royssii*, De Vern. (not Phil.) = *A. oblonga*, J. de C. Sow. = *A. obtusa* and *A. paradoxa*, M'Coy = *A. virgoides*, M'Coy	×	×	×	×		×	×			×						×	×
×	×	×	×	×	— *ambigua*, Sow. Min. Con., vol. iv, p. 105, pl. 376. Dav. Mon., p. 77, pl. xv, figs. 16—22; pl. xvii, figs. 11—14 = *T. pentaedra*, Phil. = *A. sublobata*, Portl.	×	×	×	×		×	×	×	×	×	×					×	
×				×	— *globularis*, Phil. Geol. York., vol. ii, p. 220, pl. x, fig. 22. Dav. Mon., p. 86, figs. 15—18	×	×	×					×		×							
×				×	— *subtilita*, Hall, in Howard Stansbury's Exploration of the Valley of the Great Salt Lake of Utah, p. 409, pl. ii, figs. 1, 2, 1852. Dav. Mon., pp. 18 and 86, pl. i, figs. 21, 22; pl. xvii, figs. 8—10	×	×	×	×													
×		×	×	×	*Retzia radialis*, Phil. Geol. York., vol. ii, pl. xii, figs. 40, 41. Dav. Mon., pp. 87 and 218, pl. xvii, figs. 19—21; and pl. li, figs. 4—9 = *T. mantiæ*, De Kon. (not Sow.)	×	×	×							×						×	

GENERA AND SPECIES.	WALES. Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.	SCOTLAND. Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
Terebratula hastata			×							×	×	×			×			×	×		×		
— var. *Gillingensis*																							
— *sacculus*			×							×		×			×				×				
— *vesicularis*											×	×							×				
Athyris Royssii			×	×					×	×	×	×			×			×	×	×	×		
— *expansa*																							
— *Carringtoniana*																							
? — *squamigera*																							
— *lamellosa*																							
— *plano-sulcata*										×	×	×			×			×	×		×		
— *ambigua*			×	×		×		×		×	×	×	×	×	×				×	×	×	×	
— *globularis*																							
— *subtilita*																							
Retzia radialis										×	×	×											

GENERA AND SPECIES.	IRELAND. Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
Terebratula hastata	×	×				×	×		×		×	×	×	×		×	×	×	×		×	×		×	×	×	×	×		
— var. *Gillingensis*																														
— *sacculus*		×	×			×	×					×				×		×						×	×					
— *vesicularis*																														
Athyris Royssii	×	×				×	×		×		×	×		×		×	×					×	×	×	×	×		×		
— *expansa*																														
— *Carringtoniana*																														
? — *squamigera*												×															×			
— *lamellosa*		×				×	×				×			×			×					×						×		
— *plano-sulcata*		×			×	×	×		×			×		×	×	×		×						×	×	×				
— *ambigua*		×				×						×					×		×						×					
— *globularis*																														
— *subtilita*																														
Retzia radialis											×																			

England.	Wales.	Scotland.	Ireland.	Abroad.	GENERA AND SPECIES.
×				×	*Retzia ulotrix*, De Kon. Anim. Foss. Belg., p. 292, pl. xix, fig. 5. Dav. Mon., p. 88, pl. xviii, figs. 14, 15; and pl. liv, fig. 45
	×				? — *carbonaria*, Dav. Mon., p. 219, pl. li, fig. 3
×	×		×	×	*Spirifera striata*, Martin. Pet. Derb., tab. xxxiii. Dav. Mon., pp. 19 and 221, pl. ii, figs. 12—21; pl. iii, figs. 2—6; and pl. lii, figs. 1, 2 = *T. spirifera*, Val., apud Lamarck = *S. attenuatus*, Sow. = *princeps*, M'Coy
×			×	×	? — *Mosquensis*, Fischer de Waldheim. Prog. sur les Choristite, p. 8, No. 1, 1837. Dav. Mon., pp. 22 and 221, pl. iv, figs. 13, 14 = *C. Sowerbyi* and *Kleinii*, Fischer = *S. choristites*, V. Buch
×	×	×	×	×	— *duplicicosta*, Phillips. Geol. York., vol. ii, p. 218, pl. x, fig. 1. Dav. Mon., p. 24, pl. iii, figs. 3, 4?, 5—11; pl. v, figs. 35—37; pl. lii, fig. 6
×					— var. *humerosa*, Phillips. Geol. York., vol. ii, p. 218, pl. ix, fig. 8. Dav. Mon., pp. 23 and 221, pl. iv, figs. 15, 16
×	×	×	×	×	— *trigonalis*, Martin. Pet. Derb., tab. xxxvi, fig. 1. Dav. Mon., pp. 29 and 222, pl. iv, figs. 1, 2; pl. v, figs. 1, 23, 24, and 38, 39; pl. vi, figs. 1—22; pl. vii, figs. 1 and 4, 7—16; and pl. l, figs. 3—9 = *S. bisulcata*, Sow.; Dav. p. 31 = *Sp. crassa*, De Kon., p. 25 =? *Sp. grandicostata*, M'Coy, p. 33 = *S. transiens*, M'Coy, p. 33
×			×	×	— *convoluta*, Phillips. Geol. York., vol. ii, p. 217, pl. ix, fig. 7. Dav. Mon., pp. 35 and 223, pl. v, figs. 9—15 (2—8 excluded); pl. l, figs. 1, 2
×	×		×	×	— *triangularis*, Martin. Pet. Derb., pl. xxxvi, fig. 2. Dav. Mon., pp. 27 and 223, pl. v, figs. 16—24; and pl. l, figs. 10—17 = *S. ornithorhynca*, M'Coy
×					? — *fusiformis*, Phillips. Geol. York., vol. ii, p. 217, pl. ix, figs. 10, 11. Dav. Mon., p. 56, pl. xiii, fig. 15 (a very doubtful species)
×			×		— *rhomboidea*, Phillips. Geol. of York., vol. ii, p. 217, pl. ix, figs. 8, 9. Dav. Mon., p. 36 (foot-note), and p. 223, pl. v, figs. 2—8
×					— *acuta*, Martin. Pet. Derb., pl. xlix, figs. 15, 16. Dav. Mon., p. 224, pl. lii, figs. 6, 7
×				×	— *planata*, Phillips. Geol. York., vol. ii, p. 219, pl. x, fig. 3. Dav. Mon., pl. vii, figs. 25—36
×	×		×	×	— *cuspidata*, Martin. Trans. Lin. Soc., vol. iv, p. 44, figs. 1—6. Dav. Mon., p. 44, pl. viii, figs. 19—24; pl. ix, figs. 1, 2; pl. lii, fig. 3 = *Cyrtia simplex*, M'Coy (not Phillips)
×					? — *subconica*, Martin. Pet. Derb., tab. xlvii, figs. 6—8. Dav. Mon., pp. 48 and 224, pl. ix, fig. 3; pl. lii, fig. 4
×			×	×	— *distans*, Sow. Min. Con., tab. 494, fig. 3. Dav. Mon., pp. 46 and 224, pl. viii, figs. 1—17; pl. lii, fig. 5 = *S. bicarinata*, M'Coy (p. 47, pl. viii, fig. 18)
			×		— *mesogonia*, M'Coy. Synopsis Carb. Foss. Ireland, p. 137, pl. xxii, fig. 13. Dav. Mon., p. 48, pl. vii, fig. 24

ENGLAND.

Species	Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
Retzia ulotrix	×	×								×							
carbonaria																	
Spirifera striata	×	×	×				×	×		×		×			×	×	
Mosquensis	×	×														×	
duplicicosta	×	×	×	×			×	×		×		×			×	×	
var. humerosa	×																
trigonalis	×	×	×	×		×	×	×		×	×				×	×	×
convoluta	×	×	×							×							
triangularis	×	×	×				×	×		×							
fusiformis	×																
rhomboidea	×	×	×					×		×						×	
acuta	×	×															
planata	×	×	×					×		×							
cuspidata	×	×	×	×				×		×	×	×			×	×	
subconica		×								×		×					
distans	×	×	×							?							
mesogonia																	

WALES. / SCOTLAND.

Species	Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.	Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
Retzia ulotrix																							
carbonaria	×																						
Spirifera striata	×																						
Mosquensis																							
duplicicosta			×							×		×			×			×	×		×		
var. humerosa																							
trigonalis	×		×	×	×		×			×	×	×		×	×			×	×	×	×		×
convoluta																							
triangularis				×																			
fusiformis																							
rhomboidea																							
acuta																							
planata																							
cuspidata					×		×																
subconica																							
distans																							
mesogonia																							

IRELAND.

Species	Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
Retzia ulotrix																														
carbonaria																														
Spirifera striata		×				×	×		×		×	×		×		×	×	×	×		×	×	×	×		×		×		
Mosquensis		×												×																
duplicicosta	×	×				×	×					×					×	×							×					
var. humerosa																														
trigonalis	×	×	×	×		×	×		×			×		×	×	×	×	×	×			×	×	×	×	×	×	×		
convoluta						×	×																							
triangularis		×										×		×																
fusiformis																														
rhomboidea		×				×	×		×			×						×				×				×		×		
acuta																														
planata																														
cuspidata		×				×	×			×	×	×		×										×		×		×		
subconica																														
distans		×				×	×				×	×								×				×	×	×		×		
mesogonia												×																×		

England.	Wales.	Scotland.	Ireland.	Abroad.	GENERA AND SPECIES.
×	...	×	×	×	*Spirifera pinguis*, Sow. Min. Con., vol. iii, p. 125, tab. 271. Dav. Mon., p. 50, pl. x, figs. 1, 2 = *S. rotundata*, Sow. = *S. subrotundata*, M'Coy
×	×	×	×	×	— *ovalis*, Phillips. Geol. York., vol. ii, p. 219, pl. x, fig. 5. Dav. Mon., p. 53, pl. ix, figs. 20—26; pl. lii, fig. 8 = *S. exarata*, Fleming = *B. hemisphærica*, M'Coy
×	...	...	×	×	— *integricosta*, Phillips. Geol. York., vol. ii, p. 219, pl. x, fig. 2. Dav. Mon., p. 55, pl. ix, figs. 13—19 = ? *A. rotundatus*, Martin = ? *S. paucicosta*, M'Coy
×	...	...	×	×	— *triradialis*, Phillips. Geol. York., vol. ii, p. 219, pl. x, fig. 7. Dav. Mon., p. 49, pl. ix, figs. 4—12 = *S. trisulcosa* and *S. sexradialis*, Phillips
×	...	...	...	...	? — *Reedii*, Dav., p. 43, pl. v, figs. 40—47 (doubtful species)
×	×	×	×	×	— *glabra*, Martin. Pet. Derb., pl. xlviii, figs. 9, 10. Dav. Mon., pp. 59 and 225, pl. ix, figs. 1—9; and pl. xii, figs. 1—5, 11, 12 = *Sp. obtusus* and *S. oblatus*, Sow.; *S. linguifera*, *S. symmetrica* and *S. decora*, Phillips = *S. rhomboidalis*, M'Coy, pl. xii, figs. 6, 7
...	...	...	×	...	— *Carlukensis*, Dav. Mon., p. 59, pl. xiii, fig. 14
×	...	×	×	×	— *Urii*, Flem. Brit. Animals, p. 376. Dav. Mon., p. 58, pl. xii, figs. 13, 14 = *S. Clannyana*, King
×	×	×	×	×	— *lineata*, Martin. Pet. Derb., tab. xxxvi, fig. 3. Dav. Mon., pp. 62 and 225, pl. xiii, figs. 4—13 (pl. li, fig. 15) = *S. mesoloba*, Phillips = *S. reticulata*, M'Coy = *S. imbricata*, Sow. = *S. Martini*, Flem. = *S. Stringocephaloides*, M'Coy
×	...	...	×	×	— *elliptica*, Phillips. Geol. York., vol. ii, p. 219, pl. x, fig. 16. Dav. Mon., p. 63, pl. xiii, figs. 1—3
×	×	×	×	×	*Spiriferina laminosa*, M'Coy. Synopsis Carb. Foss. Ireland, p. 137, pl. xxi, fig. 4. Dav. Mon., p. 36, pl. vii, figs. 17—22 = *Sp. hystericus*, De Kon. (not of Schlotheim) = *S. speciosa*, M'Coy (not Schlot.) = *S. tricornis*, De Kon.
×	×	×	×	×	— *cristata*, Schloth.; var. *Octoplicata*, Sow. Min. Con., p. 120, pl. 562, figs. 2—4; Dav. Mon., pp. 38 and 226, figs. 37—47, pl. lii, figs. 9, 10, 13 = *S. partita*, Port., p. 41, pl. vii, figs. 60, 61
×	...	...	×	...	— var. *biplicata*, Dav., p. 226, pl. lii, figs. 11, 12
×	...	...	...	...	? — *minima*, Sow. Min. Con., p. 105, tab. 377, fig. 1. Dav. Mon., p. 40, pl. vii, figs. 56—59 (a doubtful species)
×	...	×	×	×	— *insculpta*, Phil. Geol. York., vol. ii. p. 216, pl. ix, figs. 2, 3. Dav. Mon., p. 42, pl. vii, figs. 48—55; pl. lii, figs. 14, 15 = *S. crispus* and *heteroclytus*, De Kon. (not Linnæus nor Defrance) = *S. quinqueloba*, M'Coy = *S. Koninckiana*, D'Orbigny
×	...	...	...	×	*Cyrtina septosa*, Phillips. Geol. York., vol. ii, p. 216, pl. ix, fig. 7. Dav. Mon., p. 68, pl. xiv, figs. 1—10; pl. xv, figs. 1, 2; pl. l, fig. 19; pl. li, figs. 17, 18
...	...	...	×	...	? — *dorsata*, M'Coy. Syn. of the Carb. Foss. of Ireland, p. 136, pl. xxii, fig. 14

ENGLAND.

Species	Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
Spirifera pinguis	×	×	×					×		×							×
— ovalis	×	×	×				×	×		×							
— integricosta	×	×	×				×	×		×							
— triradialis	×	×	×				×			×							
? — Reedii	×																
— glabra	×	×	×	×		×	×	×		×					×	×	×
— Carlukensis																	
— Urii	×	×					×			×						×	×
— lineata	×	×	×		×	×	×	×		×	×			×	×	×	
— elliptica	×	×	×	×						×							
Spiriferina laminosa							×	×		×							
— cristata	×	×					×			×	×				×		
— var. biplicata	×									×							
? — minima		×															
— insculpta	×	×	×					×		×							
Cyrtina septosa	×	×	×		×					×		×			×	×	
? — dorsata																	

WALES. SCOTLAND.

Species	Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.	Lanarkshire.	Renfrewshire.	Aryshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
Spirifera pinguis										×													
— ovalis				×						×		×			×				×	×			
— integricosta																							
— triradialis																							
? — Reedii																							
— glabra		×	×	×			×			×	×	×			×				×				×
— Carlukensis										×	×	×											
— Urii										×	×	×			×			×			×		
— lineata	×						×			×	×	×	×	×	×			×	×		×		×
— elliptica																							
Spiriferina laminosa			×							×		×									×	×	
— cristata						×				×	×	×	×		×			×	×		×		
— var. biplicata																							
? — minima																							
— insculpta										×			×										
Cyrtina septosa																							
? — dorsata																							

IRELAND.

Species	Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
Spirifera pinguis	×	×		×		×	×		×		×	×		×		×	×	×				×	×	×	×	×		×		
— ovalis	×		×													×	×									×				
— integricosta	×	×					×					×					×	×							×	×				
— triradialis		×				×																								
? — Reedii																														
— glabra	×	×		×	×	×			×		×	×		×		×	×	×		×		×			×	×				
— Carlukensis																														
— Urii						×	×		×								×							×						
— lineata	×	×	×	×		×	×		×		×	×		×		×	×	×	×			×		×				×		
— elliptica		×				×	×					×																		
Spiriferina laminosa		×				×	×				×						×							×		×		×		
— cristata						×	×											×					×		×					
— var. biplicata		×																												
? — minima																														
— insculpta		×				×	×				×						×	×	×								×			
Cyrtina septosa																														
? — dorsata		×																												

England.	Wales.	Scotland.	Ireland.	Abroad.	GENERA AND SPECIES.	ENGLAND. Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
×				×	*Cyrtina carbonaria*, M'Coy. Brit. Pal. Foss., p. 442, pl. iii^{D}, figs. 12—18. Dav. Mon., p. 71, pl. xv, figs. 5—14				×													
×			×	×	*Rhynchonella reniformis*, Sow. Min. Con., pl. 496, figs. 1—4. Dav. Mon., p. 90, pl. xix, figs. 1—7	×	×	×					×		×							
×			×	×	? — *cordiformis*, Sow. Min. Con., pl. 495, fig. 2. Dav. Mon., p. 92, pl. xix, figs. 8, 9, 10 (species still doubtful)	×		×							×							
×			×	×	— *acuminata*, Martin. Pet. Derb., pl. xxxii, figs. 7, 8. Dav. Mon., p. 93, pl. xx, figs. 1—13; pl. xxi, figs. 1—20 = *T. platyloba*, Sow. = *T. mesogonia*, Phillips	×	×	×					×		×						×	
×		×	×	×	— *pugnus*, Martin. Pet. Derb., tab., xxii, figs. 4, 5. Dav. Mon., p. 97, pl. xxii, figs. 1—15 = ? *T. sulcirostris*, Phillips = ? *A. laticliva*, M'Coy	×	×	×	×				×		×						×	
×	×	×	×	×	— *pleurodon*, Phillips. Geol. York., vol. ii, p. 222, pl. 12, figs. 25—30 (but not 16). Dav. Mon., p. 101, pl. xxiii, figs. 1—15, 16—22 ? = *T. mantiæ*, Sow. = *T. ventilabrum*, Phil. = *T. pentatoma*, De Kon. (not Fischer) = *A. triplex*, M'Coy = *T. Davreuxiana*, De Kon.	×	×	×	×	×	×	×	×		×	×					×	
×			×		— *flexistria*, Phillips. Geol. York., vol. ii, p. 222, pl. xii, figs. 33, 34. Dav. Mon., p. 105, pl. xxiv, figs. 1 — 8 = *T. tumida*, Phil. = *H. heteroplycha*, M'Coy	×	×	×			×		×		×							
×			×	×	— *angulata*, Linnæus. Systema Naturæ, i, pars 2, p. 1154. Dav. Mon., p. 107, pl. xix, figs. 11—16 = *T. excavata*, Phil.	×	×						×		×							
×				×	— *trilatera*, De Kon. Anim. Foss. de la Belgique, p. 292, pl. xix, fig. 7. Dav. Mon., p. 109, pl. xxiv, figs. 23—26	×	×	×					×		×							
×			×		? — ? *gregaria*, M'Coy. Synopsis Carb. Foss. of Ireland, p. 153, pl. xxii, fig. 18. Dav. Mon., p. 112, pl. xv, figs. 27, 28										×							
×					— *Carringtoniana*, Dav. Mon., p. 227, pl. xxiii, fig. 22; and pl. liii, figs. 1, 2			×							×							
					N.B. *Rhynchonella* ? *nana*, M'Coy, *Rh.* ? *semisulcata*, M'Coy, and *Rh.* or *Cam. proava*, Phil., are still so doubtful that they need not be here recorded.																	
×	×	×		×	*Camarophoria crumena*, Martin. Pet. Derb., pl. xxxvi, fig. 4. Dav. Mon., p. 113, pl. xxv, figs. 3—9 = *T. Schlotheimi*, V. Buch	×	×	×			×	×	×		×							
×			×		— *globulina*, Phil. Ency. Met. Geol., vol. iv, pl. iii, fig. 3. Dav. Mon., p. 115, pl. xxiv, figs. 9—22 = *T. rhomboidea*, Phil. = *T. seminula*, Phil. ? = *H. longa*, M'Coy	×	×	×							×						×	
×					? — *laticliva*, M'Coy. Br. Pal. Foss., p. 444, pl. iii^{D}, figs. 20, 21 (not *A. laticliva*, M'Coy, of the Synopsis). Dav. Mon., p. 116, pl. xxv, figs. 11, 12		×					×										
			×		? — *isorhyncha*, M'Coy. Synopsis, p. 154, pl. xviii, fig. 8. Dav. Mon., p. 117, pl. xxv. figs. 1, 2																	
×	×	×	×	×	*Strophomena analoga*, Phillips. Geol. York., vol. ii, p. 215, pl. vii, fig. 10. Dav. Mon., p. 119, pl. xxviii, figs. 1—13 = *Lept. distorta*, Sow. = *L. multirugata*, M'Coy	×	×	×			×	×	×		×					×	×	

Genera and Species	WALES. Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.	SCOTLAND. Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
Cyrtina carbonaria																							
Rhynchonella reniformis																							
— *cordiformis*																							
— *acuminata*																							
— *pugnus*										×	×	×			×			×	×		×	×	
— *pleurodon*			×	×						×	×	×		×	×	×		×		×	×	×	×
— *flexistria*																							
— *angulata*																							
— *trilatera*																							
— *gregaria*																							
— *Carringtoniana*																							
Camarophoria crumena				×															×				
— *globulina*																							
— *laticliva*																							
— *isorhyncha*																							
Strophomena analoga			×	×			×		×	×	×	×			×						×		

Genera and Species	IRELAND. Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
Cyrtina carbonaria																														
Rhynchonella reniformis		×					×					×						×						×			×			
— *cordiformis*		×										×																		
— *acuminata*		×				×						×		×				×										×		
— *pugnus*		×				×	×		×		×	×		×		×		×						×	×	×				
— *pleurodon*		×		×		×	×		×			×		×			×	×						×	×					
— *flexistria*						×			×			×				×			×						×					
— *angulata*						×						×						×												
— *trilatera*																														
— *gregaria*																	×		×						×					
— *Carringtoniana*																														
Camarophoria crumena																														
— *globulina*		×																												
— *laticliva*																														
— *isorhyncha*																									×					
Strophomena analoga	×	×			×	×	×		×		×	×		×		×	×	×	×			×	×		×	×	×	×	×	

England.	Wales.	Scotland.	Ireland.	Abroad.	Genera and Species.
×	×	×	×	×	*Streptorhynchus crenistria*, Phil. Geol. York., vol. ii, pl. ix, figs. 5, 6. Dav. Mon., pp. 124 and 228, pl. xxvi, figs. 1—6; pl. xxvii, figs. 1—5; pl. xxx, figs. 14, 15; pl. liii, fig. 3 = *S. senilis* and *arachnoidea*, Phillips = *Lept. anomala*, pars, Sow. = *O. umbraculum*, Portlock = ? *O. quadrata*, *O. Bechei*, *O. comata*, *O. caduca*, M'Coy = *O. Portlockiana*, Semenow = *O. Keokuk*, Hall
×	...	...	×	×	? — *Kellii*, M'Coy. Synopsis, p. 124, pl. xxii, fig. 4. Dav. Mon., p. 127, pl. xxvii, fig. 8
...	...	...	×	...	? — *cylindrica*, M'Coy. Synopsis, p. 123, pl. xxii, fig. 1. Dav. Mon., p. 128, pl. xxvii, fig. 9
×	...	×	×	×	? — *radialis*, Phillips. Geol. York., vol. ii, pl. xi, fig. 5. Dav. Mon., p. 129, pl. xxv, figs. 16—18
×	×	×	×	×	*Orthis resupinata*, Martin. Pet. Derb., tab. xlix, figs. 13, 14. Dav. Mon., p. 130, pl. xxix, figs. 1—6; pl. xxx, figs. 1—4 = *S. connivens*, Phil. = *A. gibbera*, Portlock = *O. latissima*, M'Coy
×	...	...	...	×	— *Keyserlingiana*, De Kon. Anim. Foss. Belg., p. 230, pl. xiii, fig. 12. Dav. Mon., p. 132, pl. xxviii, fig. 14
×	×	×	×	×	— *Michelini*, L'Eveillé. Mém. Soc. Géol. Fr., vol. ii, p. 39, pl. ii, figs. 14—17. Dav. Mon., p. 132, pl. xxx, figs. 6—12 = *S. filiaria*, Phil. = *O. divaricata* and *O. circularis*, M'Coy
×	...	...	...	...	? — *antiquata*, Phillips. Geol. York., vol. ii, pl. xi, fig. 20. Dav. Mon., p. 135, pl. xxviii, fig. 15
×	...	...	×	×	*Productus striatus*, Fischer. Oryct. du Gouv. de Moscow, p. 181, pl. xix, fig. 4. Dav. Mon., p. 139, pl. xxxiv, figs. 1—5; pl. liii, fig. 1 = *P. comoides*, Dillwyn (not Sow.) = *Pinna inflata*, Phillips, *Pecten tenuissima*, Eichwald = *Lima Waldaica*, V. Buch = *Leptæna anomala*, pars, J. Sow. = *P. limæformis*, V. Buch
×	×	×	×	×	— *giganteus*, Martin. Pet. Derb., pl. xv, fig. 1. Dav. Mon., p. 141, pl. xxxvii, figs. 1—4; pl. xxxviii, fig. 1; pl. xxxix, figs. 1—5; pl. xl, figs. 1—3 = *A. crassus*, Martin = *P. aurita* and *Edelburgensis*, Phillips = *Lept. variabilis*, Fischer = *Prod. gigas*, V. Buch = *L. maxima*, M'Coy
×	×	...	...	...	? — *hemisphæricus*, J. Sow. Min. Con., tab. 328 (not tab. 561). Dav. Mon., p. 144, pl. xl, figs. 4—9
×	×	×	×	×	— *latissimus*, J. Sow. Min. Con., tab. 330. Dav. Mon., p. 145, pl. xxxv, figs. 1—4
×	...	...	...	×	? — *humerosus*, Sow. Min. Con., tab. 322. Dav. Mon., p. 147, pl. xxxvi, figs. 1, 2
×	×	×	×	×	— *cora*, D'Orbigny. Pal. du Voy. dans l'Amerique Meridionale, pl. v, figs. 8—10. Dav. Mon., p. 148, pl. xxxvi, fig. 42, fig. 9 = *P. comoides*, De Kon. (not Sow.) = *P. corrugata*, M'Coy = *P. Neffedievi*, De Vern. = *P. pileiformis*, M'Chesney
×	...	...	...	×	— *undiferus*, De Kon. Mong. du Genre Productus, pl. v, fig. 4; and pl. xi, fig. 5. Dav. Mon., p. 230, pl. liii, figs. 5, 6 = *P. spinulosus*, De Kon. (not Sow.)

ENGLAND.

Species	Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
Streptorhynchus crenistria	×	×	×	×			×	×	×	×	×				×	×	×
Kellii																×	
cylindrica																	
radialis	×	×	×							×					×	×	
Orthis resupinata	×	×	×	×		×	×	×		×					×	×	×
Keyserlingiana	×									×							
Michelini	×	×	×			×	×	×		×	×				×	×	×
antiquata	×																
Productus striatus	×	×	×					×		×					×	×	
giganteus	×	×	×	×	×	×	×	×		×	×				×	×	
hemisphæricus	×			×							×				×	×	
latissimus	×	×	×		×	×	×	×		×	×						
humerosus										×		×					
cora	×	×	×	×			×	×		×					×	×	
undiferus	×																

WALES.

Species	Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.
Streptorhynchus crenistria	×	×	×	×			×		×
Kellii									
cylindrica									
radialis									
Orthis resupinata			×	×		×			×
Keyserlingiana									
Michelini			×	×		×	×		×
antiquata									
Productus striatus									
giganteus		×	×	×	×		×	×	
hemisphæricus	×		×	×				×	×
latissimus		×							
humerosus									
cora				×			×		
undiferus									

SCOTLAND.

Species	Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
Streptorhynchus crenistria	×	×	×		×	×			×	×	×	×		
Kellii														
cylindrica														
radialis	×	×	×				×							
Orthis resupinata	×	×	×	×	×	×		×	×	×	×	×	×	×
Keyserlingiana														
Michelini	×	×	×		×	×		×		×	×	×	×	
antiquata														
Productus striatus														
giganteus	×		×	×		×	×	×	×	×	×	×	×	
hemisphæricus														
latissimus	×	×	×	×	×	×								
humerosus														
cora		×	×		×	×					×			
undiferus														

IRELAND.

Species	Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
Streptorhynchus crenistria	×	×		×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×		×			×	×	×	×		
Kellii																				×					×					
cylindrica								×																						
radialis		×																×					×							
Orthis resupinata		×		×	×	×	×		×		×	×		×		×	×	×				×		×	×			×	×	
Keyserlingiana																														
Michelini		×	×			×	×					×	×					×				×		×		×		×		
antiquata																														
Productus striatus						×					×							×												
giganteus	×	×	×			×	×	×	×	×		×		×				×	×			×			×					
hemisphæricus																														
latissimus			×				×	×	×								×	×				×			×	×				
humerosus																														
cora		×				×			×			×			×		×	×	×		×	×						×		
undiferus																														

England.	Wales.	Scotland.	Ireland.	Abroad.	GENERA AND SPECIES.
×	×	×	×	×	*Productus semireticulatus*, Martin. Pet. Derb., pl. xxxii, figs. 1, 2; and pl. xxxiii, fig. 4. Dav. Mon., p. 149, pl. xliii, figs. 1—11; pl. xliv, figs. 1—4 = *A. productus*, Martin = *P. Scoticus*, *P. Martini*, *P. antiquatus*, and *P. concinnus*, Sow. = *P. pugilus*, Phil. = *A. tubulifera*, Fischer = *P. inca*, and *P. Peruvianus*, D'Orb. = *P. flexistria*, M'Coy
×	×	×	×	×	— *costatus*, J. Sow. Min. Con., pl. 560, fig. 1. Dav. Mon., p. 152, pl. xxxii, figs. 2—9 = *P. sulcatus*, Sow. = *P. costellatus*, M'Coy
×		×			— *muricatus*, Phillips. Geol. York., pl. viii, fig. 3. Dav. Mon., p. 153, figs. 10—14
×	×	×	×	×	— *longispinus*, Sow. Min. Con., pl. lxviii, fig. 1. Dav. Mon., p. 154, pl. xxxv, figs. 5—17 = *An. echinatæ*, pars, Ure. = *P. Flemingii*, *P. spinosus*, and *P. lobatus*, Sow. = *P. elegans*, Davreux = *P. setosa*, Phil. = *P. capacii*, D'Orb. = *T. tubarius*, De Key. = *P. Wabashensis* and *P. splendens*, Norwood and Pratten
×		×		×	— *sinuatus*, De Kon. Anim. Foss. de Belgique, p. 654, pl. lvi, fig. 2. Dav. Mon., p. 157, pl. xxxiii, figs. 8—11
×			×	×	— *margaritaceus*, Phillips. Geol. York., vol. ii, p. 215, pl. viii, fig. 8. Dav. Mon., p. 159, pl. xliv, figs. 5—8 = *P. pectinoides*, Phillips
×				×	? — *arcuarius*, De Kon. Anim. Foss. Belg., p. 171, pl. xii, fig. 10. Dav. Mon., p. 160, pl. xxxiv, fig. 17
		?		×	? — *carbonarius*, De Kon. Anim. Foss. Belg., pl. xii *bis*, fig. 1. Dav. Mon., p. 160, pl. xxxiv, fig. 6
×		×	×	×	— *undatus*, Defrance. Dic. Sc. Nat., vol. xliii, p. 354. Dav. Mon., p. 161, pl. xxxiv, figs. 1—13 = *P. Tortilis*, M'Coy
			×		— *Wrightii*, Dav. Mon., p. 162, pl. xxxiii, figs. 6, 7
×				×	— *proboscideus*, De Vern. Bull. Soc. G. Fr., vol. xi, p. 259, pl. iii, fig. 3. Dav. Mon., p. 163, pl. xxxiii, figs. 1—4 = *C. prisca*, Goldfuss
×				×	— *ermineus*, De Kon. Anim. Foss. Belgique, p. 181, pl. x, fig. 5. Dav. Mon., p. 164, pl. xxxiii, fig. 5
×			×	×	— *tessellatus*, De Kon. Anim. Foss. Belgique, p. 192, pl. ix, fig. 2; and pl. xiii *bis*, fig. 5 (not of Phillips). Dav. Mon., p. 165, pl. xxxiii, figs. 24, 25; pl. xxxiv, fig. 14
×				×	— *marginalis*, De Kon. Mon. du Genre Productus, pl. xiv, fig. 7. Dav. Mon., p. 229, pl. liii fig. 3
×				×	— *Nystianus*, De Kon. Desc. Anim. Foss. Belg., p. 202, pl. vii *bis*, fig. 3; pl. ix, fig. 7; pl. x, fig. 9. Dav., Mon., p. 231, pl. liii, fig. 9
×	×	×	×	×	— *aculeatus*, Martin. Pet. Derb., pl. xxxvii, figs. 9, 10. Dav. Mon., pp. 166 and 233, pl. lxiii, figs. 16—18, 20 = *P. laxispina*, Phillips

ENGLAND.

Species	Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
semireticulatus	×	×	×	×		×	×	×		×	×			?	×	×	×
costatus	×	×	×	×		×	×	×		×	×						
muricatus	×																
longispinus	×	×	×			×	×	×		×	×				×	×	
sinuatus	×	×								×							
margaritaceus	×	×	×	×						×							
arcuarius	×																
carbonarius																	
undatus	×	×	×				×	×		×							
Wrightii																	
proboscideus	×							×									
ermineus	×									×							
tessellatus	×		×					×		×							
marginalis	×																
Nystianus	×																
aculeatus	×	×		×			×	×		×							

WALES.

Species	Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.
semireticulatus	×		×	×	×	×	×	×	
costatus			×				×		
muricatus									
longispinus			×	×			×		×
sinuatus									
margaritaceus									
arcuarius									
carbonarius									
undatus									
Wrightii									
proboscideus									
ermineus									
tessellatus									
marginalis									
Nystianus									
aculeatus				×					

SCOTLAND.

Species	Lanarkshire.	Renfrewshire.	Ayrshire.	Bute-shire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
semireticulatus	×	×	×	×	×	×	×	×	×	×	×	×	×	
costatus	×	×	×	×	×	×								
muricatus			×			×								
longispinus	×	×	×	×	×	×				×	×	×	×	
sinuatus	×	×	×											
margaritaceus														
arcuarius														
carbonarius	?													
undatus	×				×	×								
Wrightii														
proboscideus														
ermineus														
tessellatus														
marginalis														
Nystianus														
aculeatus	×	×	×			×				×	×			

IRELAND.

Species	Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.
semireticulatus	×	×	×	×	×	×	×	×	×		×	×		×	
costatus			×												
muricatus															
longispinus		×		×	×	×	×		×			×			
sinuatus															
margaritaceus		×		×		×	×		×			×		×	
arcuarius															
carbonarius															
undatus		×				×			×		×				
Wrightii		×													
proboscideus															
ermineus															
tessellatus												×			
marginalis															
Nystianus															
aculeatus		×	×			×	×	×						×	

Species	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
semireticulatus	×	×	×	×	×	×	×	×	×	×	×	×	×		
costatus													×		
muricatus															
longispinus	×	×	×	×			×		×	×	×		×		
sinuatus															
margaritaceus		×	×			×		×			×	×			
arcuarius															
carbonarius															
undatus															
Wrightii															
proboscideus															
ermineus															
tessellatus															
marginalis															
Nystianus															
aculeatus	×	×		×							×				

England.	Wales.	Scotland.	Ireland.	Abroad.	Genera and Species.
×		×			*Productus Youngianus*, Dav. Mon., pp. 167 and 233, pl. xxxiii, figs. 21—23
×				×	— *Koninckianus*, De Verneuil. Russia and Ural, vol. ii, p. 253. Dav. Mon., p. 230, pl. liii, fig. 7 = *P. spinulosus*, De Kon. (not Sow.)
×	×	×	×	×	— *pustulosus*, Phillips. Geol. York., vol. ii, pl. vii, fig. 15. Dav. Mon., p. 168, pl. xli, figs. 1—6; pl. lxii, figs. 1—4 = *P. rugata* and *P. ovalis*, Phil. = *P. pyxidiformis*, De Kon.
×	×	×	×	×	— *scabriculus*, Martin. Pet. Derb., p. 8, pl. xxxvi, fig. 5. Dav. Mon., p. 169, pl. xlii, figs. 5—8 = *P. quincuncialis*, Phil. = *P. corbis*, Potiez
×	×	×	×	×	— *fimbriatus*, Sow. Min. Con., pl. 459, fig. 1. Dav. Mon., p. 171, pl. xxxiii, figs. 12—15; pl. xliv, fig. 15 = *S. marsupit*, Davreux, ? = *P. laciniata*, M'Coy
×	×	×	×	×	— *punctatus*, Martin. Pet. Derb., pl. xxxvii, fig. 6 (7, 8, *exclusa*). Dav. Mon., p. 172, pl. xliv, figs. 9—16 = *T. rugosa*, Parkinson = *A. thecarius*, Schloth. = *Lept. sulcata*, Fischer = *P. concentricus*, Potiez = *S. tubulospina*, M'Chesney = var. ? *P. elegans*, M'Coy
×				×	— *Keyserlingianus*, De Koninck. Mon. du Genre Productus, pl. xiv, fig. 6. Dav. Mon., p. 174, pl. xxxiv, figs. 15, 16
×	×	×	×	×	— *spinulosus*, Sow. Min. Con., pl. lxviii, fig. 3. Dav. Mon., p. 175, pl. xxxiv, figs. 18—21 = *P. granulosus*, Phillips = *P. papillatus*, De Kon. = *P. cancrini*, De Kon. (not of De Verneuil)
×				×	? — *Deshaysianus*, De Kon. Anim. Foss. Belg., p. 193, pl. x, fig. 7. Dav. Mon., p. 232, pl. liii, figs. 11, 12
×				×	— *plicatilis*, Sow. Min. Con., pl. 459, fig. 2. Dav. Mon., p. 176, pl. xxxi, figs. 3—5 = *Lept. polymorpha*, Muenster
×	×			×	— *sub-lævis*, De Kon. Ann. Foss. Belgique, pl. x, fig. 1. Dav. Mon., pp. 177 and 234, pl. xxxi, figs. 1, 2; pl. xxxii, fig. 1; pl. li, figs. 1, 2? = *Stroph. antiquata*, Potiez = *P. Christiani*, De Kon.
×		×	×	×	— *mesolobus*, Phillips. Geol. York., vol. ii, pl. vii, figs. 12, 13. Dav. Mon., p. 178, pl. xxxi, figs. 6—9
×	×		×	×	*Chonetes comoides*, Sow. Min. Con., pl. 329. Dav. Mon., p. 180, pl. xlv, fig. 7 (? 1—6); pl. xlvi, fig. 1
×	×		×	×	— *papilionacea*, Phillips. Geol. York., vol. ii, pl. ii, fig. 6. Dav. Mon., p. 182, pl. xlvi, figs. 3—6 = *P. flabelliformis*, Lister = *P. multidentata*, M'Coy = ? *P. papyracea*, M'Coy
×				×	? — *Dalmaniana*, De Kon. Anim. Foss. Belg., pl. xiii, fig. 3; pl. xiii *bis*, fig. 2. Dav. Mon., p. 183, pl. xlvi, fig. 7
×		×	×	×	— *Buchiana*, De Kon. Anim. Foss. Belg., pl. xiii, fig. 1. Dav. Mon., p. 184, pl. xlvii, figs. 1—7 and 28; pl. lii, fig. 21 = *L. crassistria*, M'Coy

ENGLAND.

Species	Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
Productus Youngianus	×									×							
Koninckianus	×																
pustulosus	×	×	×	×				×		×					×	×	
scabriculus	×	×	×		×		×	×		×	×		×		×	×	×
fimbriatus	×	×	×	×		×	×	×		×					×		
punctatus	×	×	×	×		×	×	×		×						×	
Keyserlingianus	×									×							
spinulosus	×	×	×				×	×		×						×	
Deshaysianus	×																
plicatilis	×	×	×							×							
sub-lævis			×							×							
mesolobus	×	×	×	×				×		×							
Chonetes comoides															×	×	
papilionacea	×	×	×	×				×		×		×			×	×	
Dalmaniana	×						×			×							
Buchiana	×			×			×			×							

WALES. SCOTLAND.

Species	Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.	Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
Productus Youngianus										×	×	×			×				×		×		
Koninckianus																							
pustulosus			×							×					×					×			
scabriculus										×	×	×		×	×				×	×	×	×	
fimbriatus			×	×						×	×	×			×					×	×		
punctatus			×	×			×			×	×	×		×	×				×	×	×		
Keyserlingianus																							
spinulosus						×				×	×	×							×	×			
Deshaysianus																							
plicatilis																							
sub-lævis			×																				
mesolobus										×	×	×			×								×
Chonetes comoides		×	×	×																			
papilionacea	×																						
Dalmaniana																							
Buchiana										×													

IRELAND.

Species	Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
Productus Youngianus																														
Koninckianus																														
pustulosus		×		×	×	×	×		×		×	×		×	×	×	×	×	×			×	×	×	×	×		×		
scabriculus	×	×	×		×	×	×		×		×	×	×	×	×	×	×	×				×	×		×			×		
fimbriatus	×	×				×	×					×		×		×	×	×	×			×		×	×	×	×			
punctatus	×	×	×		×	×	×		×			×		×		×	×	×	×	×		×	×		×			×		
Keyserlingianus																														
spinulosus		×			×	×	×		×					×			×		×			×								
Deshaysianus																														
plicatilis	×	×				×		×						×		×	×	×												
sub-lævis																														
mesolobus		×				×			×		×	×		×				×												
Chonetes comoides	×	×				×	×		×		×				×				×					×	×					
papilionacea		×			×	×	×		×			×		×		×		×	×			×			×					
Dalmaniana																														
Buchiana		×					×																							

England.	Wales.	Scotland.	Ireland.	Abroad.	GENERA AND SPECIES.
×	×	×	×	×	*Chonetes Hardrensis*, Phillips. Fig. and Des. of the Pal. Foss. of Cornwall, p. 138, pl. xl, fig. 104. Dav. Mon., p. 186, pl. xlvii, figs. 12—18
×		×	×		— *polita*, M'Coy. Brit. Pal. Foss., p. 456, pl. iiiᴰ, fig. 30. Dav. Mon., p. 190, pl. xlvii, figs. 8—11
					N.B. Several very doubtful species of Chonetes are not here tabulated (see p. 188).
×		×	×	×	*Crania quadrata*, M'Coy. Synopsis, pl. xx, fig. 1. Dav. Mon., p. 194, pl. xlviii, figs. 1—13
×			×	×	? — *Ryckholtiana*, De Kon. Anim. Foss. Belgique, pl. xxiii, fig. 5. Dav. Mon., p. 195, pl. xlviii, figs. 15, 16 (17?) = *C. vesicularis*, M'Coy
			×		? — *trigonalis*, M'Coy. Synopsis, pl. xx, fig. 2. Dav. Mon., p. 196, pl. xlviii, fig. 14
×	×	×	×	×	*Discina nitida*, Phillips. Geol. York., vol. ii, p. 221, pl. ix, figs. 10—13. Dav. Mon., p. 197, pl. xlviii, figs. 18—25 = *D. cincta*, Portlock = *D. bulla*, M'Coy = *D. Koninckii*, Geinitz
			×		? — *Davreuxiana*, De Kon. Anim. Foss. Belg., p. 306, pl. xxi, fig. 4. Dav. Mon., p. 198, pl. xlviii, fig. 26
×		×	×	×	*Lingula squamiformis*, Phillips. Geol. York., vol. ii, pl. ix, fig. 14. Dav. Mon., p. 205, pl. xlix, figs. 1—10
		×			— *Scotica*, Dav. Mon., p. 207, pl. xlviii, figs. 27, 28
×	×	×	×	×	— *mytiloides*, Sow. Min. Con., tab. xix, figs. 1, 2. Dav. Mon., p. 207, pl. xlviii, figs. 29—36 = *L. elliptica*, *L. marginata*, and *L. parallela*, Phillips
×				×	?— *Credneri*. Gunij Verst. der Zech., pl. iv, figs. 23—29. Dav. Mon., p. 209, pl. xlviii, figs. 38—40
					N.B. This is probably a synonym of *L. mytiloides*.
×					? — *latior*, M'Coy. Br. Pal. Foss., pl. iiiᴱ, fig. 23. Dav. Mon., p. 210, pl. xlviii, fig. 37

ENGLAND.

Species	Yorkshire.	Derbyshire.	Lancashire.	Westmoreland.	Cumberland.	Durham.	Northumberland.	Isle of Man.	Herefordshire.	Staffordshire.	Shropshire.	Leicestershire.	Worcestershire.	Devonshire.	Somersetshire.	Gloucestershire.	Monmouthshire.
Chonetes Hardrensis	×			×			×	×			×			×	×	×	×
— *polita*							×										
Crania quadrata															×		
? — *Ryckholtiana*		×															
? — *trigonalis*																	
Discina nitida	×	×	×				×			×	×		×		×	×	×
? — *Davreuxiana*																	
Lingula squamiformis	?		×				×										
— *Scotica*																	
— *mytiloides*	×	×	×				×			×			×		×	×	×
?— *Credneri*			×			×											
? — *latior*			×			×											

WALES.

Species	Pembrokeshire.	Anglesea.	Denbighshire.	Flintshire.	Montgomeryshire.	Brecknockshire.	Glamorganshire.	Carmarthenshire.	Carnarvonshire.
Chonetes Hardrensis	×		×	×		×	×		×
— *polita*									
Crania quadrata									
? — *Ryckholtiana*									
? — *trigonalis*									
Discina nitida						×			
? — *Davreuxiana*									
Lingula squamiformis									
— *Scotica*									
— *mytiloides*							×		
?— *Credneri*									
? — *latior*									

SCOTLAND.

Species	Lanarkshire.	Renfrewshire.	Ayrshire.	Buteshire.	Dumbartonshire.	Stirlingshire.	Dumfriesshire.	Peeblesshire.	Edinburghshire.	Linlithgowshire.	Haddingtonshire.	Fifeshire.	Berwickshire.	Kircudbrightshire.
Chonetes Hardrensis	×	×	×	×	×	×				×	×	×		
— *polita*						×								
Crania quadrata	×	×	×			×								×
? — *Ryckholtiana*														
? — *trigonalis*														
Discina nitida	×	×	×			×			×		×	×	×	
? — *Davreuxiana*														
Lingula squamiformis	×	×			×	×			×		×		×	
— *Scotica*	×													
— *mytiloides*	×	×	×			×			×			×	×	
?— *Credneri*														
? — *latior*														

IRELAND.

Species	Armagh.	Cork.	Carlow.	Clare.	Cavan.	Dublin.	Donegal.	Down.	Fermanagh.	Galway.	Kerry.	Kildare.	King's County.	Limerick.	Louth.	Longford.	Leitrim.	Meath.	Mayo.	Monaghan.	Queen's County.	Roscommon.	Sligo.	Tipperary.	Tyrone.	Waterford.	Westmeath.	Wexford.	Kilkenny.	Antrim.
Chonetes Hardrensis		×	×			×	×										×	×	×			×	×		×	×		×		
— *polita*																					×									
Crania quadrata							×																							
? — *Ryckholtiana*												×																		
? — *trigonalis*							×																							
Discina nitida		×			×	×	×																	×	×					
? — *Davreuxiana*		×																												
Lingula squamiformis									×																					×
— *Scotica*																														
— *mytiloides*						×																			×					
?— *Credneri*																														
? — *latior*																														

EXPLANATION OF THE TABLES AND LIST OF LOCALITIES.

The Carboniferous system occupies so large an area in Great Britain, that it appeared desirable to tabulate the amount of work done in collecting its Brachiopoda, and to correctly define our present knowledge with reference to their distribution. The labour required to effect this object has been very great; and although the results are no doubt far from complete, or entirely satisfactory, my tables will, I trust, serve as a groundwork to which may be hereafter added the fruit of further search in the various counties there inscribed.

When my tables had been almost completed, Mr. Salter suggested, that instead of counties, it might be preferable to divide Great Britain into Carboniferous districts, and to give the range of species in them, including in these districts the Carboniferous Limestone, Millstone-grit, and Coal, somewhat as follows:

1, The Scotch Basin; 2, Northumberland, Durham, and north of the Tees (the line of the Eden and the Tees forming a good boundary to separate from No. 2); the 3rd, or Yorkshire and North Lancaster, as far south as Wharfedale; 3A, Cumberland or Whitehaven; 4, Derbyshire, with what are called the Yorkshire and Lancashire Coal-fields on each flank; 5, North Wales and Anglesea; 6, Shropshire and the Forest of Wyre, Staffordshire and Leicestershire patches; 7, South Wales Basin; 8, Forest of Dean, Bristol, and the Mendips; 9, Devonshire; 10, Isle of Man; 11, Ireland; the last also being similarly divided.

I should have preferred arranging my tables into such natural boundaries; but besides certain difficulties, it would have necessitated another kind of research, as for many months previous I had been arranging the species in their respective counties, and which for practical purposes may not be devoid of utility.

In preparing these tables, and the following lists of localities, no trouble has been spared, for in addition to my own personal researches, which have extended over five years, I have availed myself of all the assistance that could be obtained.[1]

[1] Mr. Salter and Mr. Etheridge placed the Geological Survey manuscript lists and specimens before me, and kindly assisted with their personal observations; Mr. Waterhouse and Mr. S. P. Woodward, with their usual urbanity and desire to turn the national collection to public use, afforded me every facility to examine at leisure all the Carboniferous species in the British Museum, where Gilbertson's and Sowerby's original collections are now carefully preserved. The Geological Society's stores were also examined, as well as the collection made by the late Mr. D. Sharpe, and I have had the loan of thousands

The work in connection with British Carboniferous Brachiopoda must not, however, be supposed exhausted, for there is much still to be learnt and achieved by future observers; for out of the one hundred and twenty species enumerated in my tables, from fifteen to eighteen have not been sufficiently studied, from want of satisfactory or sufficient material, and these may hereafter prove to be partly or entirely synonyms, varieties, or variations in shape of some of the others; so that I do not consider that many more than about one hundred good species have been proved to exist in Great Britain.

Seventy-one British counties have, up to the present time, afforded Carboniferous Brachiopoda, and the following numerical statements must be considered to represent the present state of our knowledge, as some counties have been much more searched than others, so that with time these numbers will no doubt be notably modified. It will however be interesting, I think, to record the state of our information up to the early portion of 1862.

Number of Species hitherto recorded from each County.

ENGLAND.		Herefordshire	2
Yorkshire	90	Staffordshire	78
Derbyshire	76	Shropshire	19
Lancashire	69	Worcestershire	3
Westmoreland	31	Cheshire	2
Cumberland	6	Somersetshire	32
Durham	33	Monmouthshire	13
Northumberland	42	Gloucestershire	40
Isle of Man	50	Leicestershire	7

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of specimens belonging to many private collections; the following gentlemen having assisted to the utmost of their power in the working out of the lists, &c.:

IN ENGLAND—Mr. E. Wood, of Richmond; Mr. Burrow, of Settle; Mr. Reed and Mr. Dallas, of York, Yorkshire; Mr. Carrington, of Wetton; Mr. Wardle, of Leek, Staffordshire; Mr. Tate, of Alnwick, Northumberland; Mr. Hutchinson, of Durham; Mr. Binney, Mr. Ormerod, Mr. Parker, and Dr. Fleming, of Manchester; Mr. Rofe, of Preston, and Mr. Froggatt, of Stockport, Lancashire; the Rev. W. Coleman, of Ashby, Leicestershire; Prof. Sedgwick, Cambridge; Prof. Phillips, Oxford; Dr. Bowerbank, Prof. Tennant, and Mr. Rodwell, London; Mr. Walton, and Mr. Moore, Bath; Mr. W. Sanders, and Mr. W. W. Stoddart, Clifton; the Rev. J. G. Cumming, of the Isle of Man; Dr. Bevan, of Beaufort, Monmouthshire; Mr. Mushen, Birmingham, &c.

IN SCOTLAND—The late Rev. J. Fleming, and H. Miller, Mr. Page, and Mr. Geikie, of Edinburgh; Mr. Young, Mr. J. Armstrong, Mr. J. Thomson, Mr. W. Johnston, Mr. Fraser, Mr. Crosskey, and Mr. Bennie, of Glasgow; Drs. Rankin and Slimon, of Carluke and Lesmahago; Mr. W. Grossart, of Salsburgh, Lanarkshire; Prof. Nicol, of Aberdeen.

IN IRELAND—Mr. Kelly and Mr. Baily of the Geological Survey of Ireland; Mr. Carte, of the Royal Dublin Museum; Sir R. Griffith, and Mr. Byron, of Dublin; Mr. J. Wright and Prof. Harkness, Cork; and Prof. de Koninck, has also communicated to me the results of his examination of our British species.

To these gentlemen I beg to return my warmest thanks and acknowledgments for all the kind and generous assistance they have so liberally bestowed, and to whose help many of the results here recorded are mainly due.

Wales.	
Pembrokeshire	9
Anglesea	5
Carnarvonshire	8
Montgomeryshire	3
Denbighshire	24
Flintshire	23
Brecknockshire	7
Glamorganshire	15
Carmarthenshire	4
Scotland.	
Lanarkshire	46
Renfrewshire	38
Ayrshire	42
Buteshire	11
Dumbartonshire	18
Stirlingshire	41
Dumfriesshire	3
Peeblesshire	4
Edinburghshire	18
Linlithgowshire	26
Haddingtonshire	20
Fifeshire	26
Berwickshire	14
Kirkudbrightshire	7
Ireland.	
Armagh	19
Cork	57
Carlow	13
Clare	12
Cavan	13
Dublin	52
Donegal	46
Down	7
Fermanagh	31
Galway	2
Kerry	23
Kildare	44
King's County	4
Limerick	30
Louth	7
Longford	24
Leitrim	34
Meath	39
Mayo	22
Monaghan	4
Queen's County	5
Roscommon	26
Sligo	13
Tipperary	24
Tyrone	35
Waterford	26
Westmeath	8
Wexford	25
Kilkenny	2
Antrim	1

The species which have been found in the larger number of counties, or which have had the greatest range, are:

Terebratula hastata, found in	39	counties.
Athyris Royssii	35	,,
— planosulcata	29	,,
— ambigua	31	,,
Spirifera striata	25	,,
— trigonalis=bisulcata	48	,,
— glabra	37	,,
— lineata	41	,,
Rhynchonella pleurodon	35	,,
Strophomena analoga	38	,,
Streptorhynchus crenistria	50	,,
Orthis, resupinata, in	45	counties.
— Michelini	37	,,
Productus giganteus	43	,,
— semireticulatus	57	,,
— longispinus	40	,,
— pustulosus	32	,,
— scabriculus	40	,,
— fimbriatus	32	,,
— punctatus	38	,,
Chonetes Hardrensis	36	,,
Discina nitida	25	,,

All the other species are more sparingly distributed, as may be seen by a glance at the tables.

We will now mention some of the localities where Carboniferous species have been found, and class them by counties for convenience, commencing by those of

ENGLAND.

In England eighteen counties have afforded about 112 species, and is therefore richer in this respect than Wales, Scotland, or Ireland. By far the larger number of species are derived from the Carboniferous Limestone (Lower Scar Limestone, and its accompanying shales); the Yoredale rocks, Millstone-grit and Coal Formation having offered a much smaller proportion. Carboniferous Brachiopoda have been noticed in England as early as 1685-1692; for several recognisable species will be found in Listers' 'Historia Sive Synopsis Methodica Conchyliorum et Tubularum Marinarum,' vol. iv, in fol., cum tab œneis; but it was not until 1809 that they were seriously collected or studied, and in p. 7 of the present monograph, as well as in the body of the work, references to those authors who have published upon the subject will be found.

Yorkshire.—Settle; Clattering Dykes, and Malham Moor, Otterburn, all at about six miles distant from Settle, and all in the Craven district; Craco, Bunsall, Grassington, Greenhow Hill, localities on or near the river Wharfe; Whitewell, eight miles west of Clitheroe; Sykes, five miles from Whitewell; Slaidburn, Newton—these four last are in Bolland proper; Withgill, two miles from Clitheroe, and the same distance from Mitton; Richmond; Gilling, three miles north of Richmond; Marslie, five miles west of Richmond; Washton, three miles north-west of Richmond; Downholm, five miles west of Richmond; Barton, six miles north of Richmond; Askrigg; Thornton, three miles south of Askrigg; Aysgarth, six miles south-east of Askrigg; West Witton, four miles west of Leyburn; Kettlewell; Cray, one mile north of Kettlewell; Linton, six miles south of Kettlewell; Thorp, seven miles south of Kettlewell. For this list of localities I am indebted to Mr. E. Wood, of Richmond; to Mr. J. Parker, of Manchester; and to Mr. Burrow, of Settle.

Lancashire.—Clitheroe; Chatburn, two miles, Downham, three miles, and Twiston, five miles north-east of Clitheroe; Worston; Harbour in the township of Thornley, near Longridge, six miles, and Harbour eight miles north-east of Preston; Thornley, near Chipping, about ten miles north-east of Preston; Ulverston; Scales, near Ulverston Conishead; Kirby Lonsdale, on the borders of Westmoreland. These localities have been made out by Mr. J. Parker and Mr. Rofe.

Westmoreland.—Kendal.

Cumberland.—Chawk, near Rose Castle; Buxton Fall. Poltross Burn; Bird Oswuld; Combe Crag; Bank Head, Harehill—these localities have been furnished me by Mr. Tate, and are within one to five and a half miles of Lanercost.

Durham.—Stanhope limestone quarry; Silvertongue Mine, near Muggleswick; Hysehope Burn; Muggleswick; Waskerley Mine; Muggleswick; Thimbleby Hill, near Stanhope; Rookhopedale; East Gate, near Stanhope; Bishopley quarries; Buffside, parish of Edmondbyers; (these localities have been mentioned to me by Mr. G. Tate, and Mr. T. Hutchinson); Wolsingham (Sow.)

Staffordshire.—Wetton parish generally; Wetton Hill, about ten miles from Leek; Narrowdale, Gateham, Allstonefield; Beeston Tor; Butterton, eight miles east, and Mixon, five miles north-east of Leek; Ilam, near Dovedale, twelve miles from Leek; Waterhouses, about five miles on Ashbourne road; Bed of the Manyfold, near Wetton; Ecton, near Warslow, about ten miles from Leek; Grindon parish, Caldon Low quarries, at about seven miles from Leek, in the direction of Ashbourne. Longnor is in Staffordshire, but on Millstone-grit; the limestone is on the Derbyshire side of the Dove, at this side of its boundary. These localities have been well searched by Messrs. S. Carrington, T. Wardle, and J. Parker. A very fine series of these fossils, collected during several years by Mr. Carrington, are preserved in the museum of the late T. Bateman, Esq., of Lomberdale House, Youlgrave, Staffordshire.

Northumberland. This list has been communicated by Mr. G. Tate, of Alnwick.

Sea Coast north of the Coquet.

Spittal	near Tweedmouth.		
Scremerstone	from Berwick	2 miles	S. by E.
Cheswick	,, ,,	4 ,,	,,
Fenham	,, Beal	2 ,,	,,
Budle	,, Belford	3 ,,	E.
North Sunderland	Chathill	3½ ,,	N.E.
Beadnell	North Sunderland	2 ,,	S.
Newton-by-the-Sea	from Chathill	4 miles	S.E.
Embleton	from Christon Bank	2 ,,	E.
Dunstan	,, ,,	3 ,,	S.E.
Craster	,, Alnwick	6 ,,	N.E.
Howick	,, ,,	5½ ,,	E.N.E.
Alnmouth	,, ,,	4½ ,,	E. by S.

Islands—Lindisfarne and Farne.

Inland.

Hetton	from Lowick	3 miles	S.
Ford	,, ,,	4½ ,,	W.
Chatton	,, Belford	5 ,,	S.W.
Belford			
Spindlestone	,, Belford	3 ,,	E. by S.
Lucker	,, ,,	4 ,,	S.E.
Christon Bank	from Alnwick	6 ,,	N.N.E.
Rock	,, ,,	4½ ,,	N. by E.
Rennington	,, ,,	3½ ,,	N. by E.
Little Mill	,, Alnwick	4 ,,	N.E.
Denwick Lane	,, Alnwick	2½ ,	N.E.
Denwick Mill	,, ,,	1½ ,,	E.

Ratcheugh	from	Alnwick	2½	miles	E. by N.
Calishes	,;	,,	2	,,	S.E.
Shilbottle	,,	,,	3	,,	S.S.E.
Whittle	,,	,,	4½	,,	S. by E.
Newton-on-the-Moor		,,	5	,,	S.
Framlington	,,	Felton	4	,,	W. by N.
Kyloe	from	Belford	5½	,,	N.W.
Eglingham	,,	Alnwick	6	,,	N.W.
Hobberlaw	,,	,,	1	,,	S. by W.
Alnwick Moor	,,	,,	1	,,	S.S.W.
Rugley	,,	,,	2	,,	S.
Lemmington	,,	,,	3½	,,	S.S.W.

South of the Coquet.

Wards-Hill	from	Framlington	4	miles	S.W.
Whitton	,,	Rothbury	½	,,	S.W.
Tosson	,,	,,	2	,,	W.
Grasslees	,,	,,	5½	,,	W. by S.
Horsley Birks	,,	Framlington	3	,,	S.
Hartington	,,	Kirkwhelpington	3	,,	N. by E.
Sandhoe	,,	Hexham	2½	,,	N.E.
Belsay	,,	Stamfordham	4	,,	N. by E.
Stamfordhand	,,	Newcastle	12	,,	N.N.W.
Sweethope	,,	Kirkwhelpington	3	,,	S.W.
Carter Fell		Sources of the Reed, near the Borders			
Shittleheugh	from	Otterburn	2	,,	N.W.
Otterburn		On Reed Water			
Redesdale	,,	Bellingham	4	,,	E.
Tone	from	Bellingham	4½	miles	S.E.
Buteland	,,	,,	3	,,	S.E.
Four Laws	,,	,,	4	,,	E.S.E.
Risingham		,,	3		N.E.
Keilder	,,	,,	15	,,	N.N.W.
Lewis Burn	,,	,,	13	,,	N. by N.
Plashetts	,,	,,	11	,,	N.N.W.
Otterstone Lee	,,	,,	11	,,	W. by W.
Billing Burn	,,	,,	10	,,	W.N.W.
Whickhope	,,	,,	11	,,	W.
Falstone	,,	,,	8	,,	W.N.W.
Bellingham		On North Tyne			
Harlow Hill	from	Newcastle	11	,,	W. by N.
Brunton	,,	Hexham	3½	,,	N.W.
Fallow Field	,,	,,	3	,,	N.W.
Chesterholm	,,	,,	10	,,	W. by N.
Haltwhistle		On South Tyne.			

Cheshire.—Carboniferous rocks occur sparingly in this county, and it was only quite recently that Mr. J. Parker, of Manchester, found Brachiopoda, viz., *Strophomena analoga*, and some spines of *Producta* in Carboniferous Limestone, immediately under the Millstone grit at Newbold, Aspburg, near Congleton, in Cheshire. Mr. Binney is inclined to believe that some Lingulæ may perhaps occur among the Goniatites and Pectens of Dunkenfield?

Derbyshire.—Parkhill, in the parish of Earl Sterndale, near Jericho Church, Sterndale; Helter Hill, Crowdecote, Pilsbury Hartington—the above close to the river Dove (above Dovedale proper); Birch Quarry, Ashford; Bowdale-house, Bakewell, Matlock-bridge, Royston, Corwen, Alport, Grindlow near Tidswell, Kniveton (four miles north-north-east of Ashburn), Parwich, near Ballidon; Tickenhall; Blue John Cavern, Cave Dale, close to Castleton. These localities are all well known, and have afforded rich stores of valuable fossils.

Shropshire.—Oswestry, Ilanymynack Hill, near Oswestry (this last locality is in

Shropshire, just on the border, in fact; the boundary line is south, and Montgomeryshire runs through the hill of Ilanfyllin). Steeraway, Coal-brook-dale, Lilles Hall, Wellington; Treflack Oswestry; Old Statch Wrekin, Clee Hill. Several of these localities have been studied by the Geological Survey and other geologists.

Leicestershire.—Ashby-de-la-Zouch, Breedon Hill and Breedon Cloud Wood; Barrow Hill, Asgathorpe, Gracedieu. These localities (in limestone, all more or less dolomized, and forming five distinct outlines in the Red Marl) have been studied by the Rev. W. Coleman; see also Hull's 'Report on the Geology of the Leicestershire Coal Field.'

Worcestershire.—In coal measures near Dudley.

Herefordshire.—Houl Hill, near Ross. The other side of the river is Chepstow, in Monmouthshire. (From unpublished lists of the 'Geological Survey.')

Monmouthshire.—Rhymney, Beaufort, Glan Rhymney, or Rhymney Gate; Cwm-Bryn-ddu, Dowlais, Clydach, Pontypool; Ebbwvale, Chepstow. All these localities have been well studied by Dr. Bevan.

Gloucestershire.—River Avon, Cook's Folly Wood, Clifton rocks, &c. Westbury; Olveston; Alveston, Tytherington; Cromhall; Tortworth; Wickwar; Chipping Sodbury; Mitcheldean; Coleford, Briavels, Granham Rocks; Under Lansdown, Bath; Wick, near Bath.

Devonshire.—Westleigh, Brushford, Pilton, Coddon Hill. The exact position and palæontological contents of the Carboniferous group in Devonshire does not appear to have been as yet completely worked out. It is believed by some geologists that the upper part of the Pilton group may perhaps belong to the Carboniferous series.

Somersetshire.—Leigh Woods, opposite Cook's Folly and Clifton; Broadfield Down (Clevedon) near Bristol; Weston-super-Mare; Portishead; Sims Hill, Broadfield Down, Bristol; Wrington; Burrington Coombe; Axbridge; South side of the Mendips; Nunney, near Frome; Binegar; Charter House, Mendip Hills; Banwell; Sheep Mayswood, Broadfield Down, Bristol; Broadfield Farm, north-east of Wrington; Blagdon; Burrington Ham, south-west of Blagdon; Lower Farm, south of Blagdon; Stoke Farm, three miles north of Wells; West Horrington, north-east of Wells; Penhill House, north-east of Wells; Whatley House, near Frome; Vallis, near Frome; Whatcomb Farm, near Frome; Cannington, near Bridgewater;

Uphill; Cheddar. For the knowledge of many of these localities, as well as for some in Gloucestershire, I am indebted to the Geological Survey, to Messrs. Salter, Etheridge, Moore, Walton, and W. Stoddart, &c.

WALES.

In Wales, nine counties have hitherto afforded about forty species; Denbighshire, Flintshire, and Glamorganshire, having produced the largest number.

The following are the principal localities with which I am at present acquainted, and are to some extent taken from the unpublished lists of the Geological Survey of that portion of Great Britain:

Pembrokeshire.—Skrinkle (lower black Carboniferous shales), Tenby; Caldy, Giltar Point. Pembroke dockyard.

Anglesea.—Llynback, six miles east of Llanerchymedd, Pencaint, Llangefri.

Carnarvonshire.—Great Ormes Head.

Denbighshire.—Langollen Crags; Tyfyn-uchaf, near Ruabon; Chirk.

Flintshire.—Mold; Bryn-davin-mold; Halken Mountain; Holywell.

Brecknockshire.—Not far from Rymney Gate.

Glamorganshire.—Cowbridge; Castle Mumbles; Newton.

Carmarthenshire.—Cromanmon, north of Curnammon.

Montgomeryshire.—Lanfyllin. This locality is close to the boundary line of Shropshire, and near Oswestry.

SCOTLAND.

In Scotland fourteen counties have afforded fifty species;[1] and it has been calculated by Prof. Nicol that the Carboniferous strata cover nearly a seventeenth of the entire surface of the country; but it is very difficult to form a correct estimate, on account of the numerous breaks from intrusive igneous rocks, rendering mapping very complex. It is, however, in the central portion of Scotland that the rocks which we are now describing

[1] All the species and their localities have been described in my monograph of the Carboniferous Brachiopoda of Scotland, published in the 'Geologist' for 1860.

occupy the greatest surface; they form there a wide sub-parallel band of nearly one hundred miles in length by some fifty in breadth, extending from the northern portion of the Frith of Forth to the Clyde, and as far as the extremity of Cantyre. No portion of the system appears to have been discovered in the north: but in the south there exists a narrow band, or separate patches, which extend along the frontiers of Scotland and England, from Berwick to near Kircudbright, on the Solway Frith.

Scottish Carboniferous deposits differ, however, from strata of a similar age, existing both in England and Ireland, in the manner in which the various beds of encrinal and coralline limestones are intercalated with coal-beds and bituminous schists in the lower parts of the system. In no single locality do we find a section in which all the beds occur in regular and uninterrupted succession; the absence of some or the thinning-out of others constitute local differences which may always be expected and duly considered. Thus in Lanarkshire generally, as well as in other parts of the Clydesdale coal-field, the Carboniferous strata have been divided into four principal groups, viz.—1. The Upper Coal series. 2. The Upper Limestone series. 3. The Lower Coal measures. 4. The Lower Limestone series. In all but the Upper Coal series Brachiopoda have been found; they appear, however, more numerous in the second and fourth divisions.

At p. 6, we alluded to David Ure's valuable work published in 1793, in which twelve species of Carboniferous Brachiopoda have been described and figured; and it would appear from an extract taken from George Crawford's 'History of Renfrewshire,' that in the beginning of last century there was a collector of fossils (the Rev. Robert Wodrow, who died in 1757) in Renfrewshire, and that though Ure was the first that figured and described Scottish fossils, he was not the first upon record that collected them, and indeed from their great abundance one cannot feel surprised that they should have attracted some notice, although they could not be understood at a period prior to the introduction of the science of Palæontology.

List of Localities in Scotland where Carboniferous Brachiopoda have been found.

LANARKSHIRE.

	Distance and direction from Carluke Church.	Stratigraphic position below the Ell coal.	Nature of strata.
Belston Place Burn . .	$1\frac{1}{4}$ miles N.	160 fathoms.	Slaty ironstone.
Belston Place Burn . .	$1\frac{1}{4}$,, N.	173 ,,	Ironstone shales.
Gare Limestone . .	2 ,, N.E.	239 ,,	
Westerhouse . .	3 ,, E.N.E.		Old shale heaps.
Bashaw . . .	$1\frac{1}{2}$,, N.E.		
Whiteshaw . .	$\frac{1}{4}$,, W.		
Belston Burn Limestone . .	$\frac{1}{2}$,, N.E.	265 ,,	Limestone and shales.
Maggy Limestone . .	. .	300 ,,	
Brocks Hole . .	1 ,, E.		
Below Whiteshawbridge .	1 ,, W.		Ironstone and shales.
Near Chapel . .	2 ,, S.		

	Distance and direction from Carluke Church.	Stratigraphic position below the Ell coal.	Nature of strata.
Lingula Ironstone		317 fathoms.	
Braidwood Gill	2 miles S.		Ironstone and shale.
Lingula Limestone	2 ,, S.	337 ,,	
Hallcraig Bridge	$1\frac{1}{2}$,, W.		Limestone and shales.
Raes Gill	2 ,, W.		
Langshaw Burn	1 ,, S.E.		
Braidwood Burn	2 ,, S.		
1st Kingshaw Limestone		338 ,,	
Hallcraig Bridge	$1\frac{1}{2}$,, W.		Limestone and shales.
Kingshaw	1 ,, N.E.		
2nd Kingshaw Limestone		341 ,,	
Hallcraig Bridge	$1\frac{1}{2}$,, W.		Limestone and shales.
Langshaw	1 ,, S.E.		
Kingshaw	1 ,, N.E.		
1st Calmy Limestone		343 ,,	
Raes Gill	2 ,, W.		Limestone and shales.
Braidwood	$1\frac{1}{2}$,, S.		
Langshaw	1 ,, S.E.		
Waygateshaw	1 ,, S.		
Headsmuir	$1\frac{1}{4}$,, S.E.		
Raes Gill Limestone		354 ,,	
Raes Gill	2 ,, W.		Alternate beds of ironstone and shales.
Waygateshaw	1 ,, S.		
Braidwood	$1\frac{1}{2}$,, S.		
Langshaw	1 ,, S.E.		
Kilcadzow	3 ,, E.		
Hill Head	1 ,, E.		
Hosie's Limestone		356 ,,	
Hillhead	1 ,, E.		Limestone and shale.
Raes Gill	2 ,, W.		
Waygateshaw	1 ,, S.		
Braidwood	$1\frac{1}{2}$,, S.		
Mosside	1 ,, N.E.		
2nd Calmy Limestone		371 ,,	
Braidwood	1 ,, S.		Limestone and shales.
Mosside	1 ,, N.E.		
Kilcadzow	3 ,, E.		
Main Limestone		375 ,,	
Braidwood	$1\frac{1}{2}$,, S.		Limestone and shales.
Langshaw	1 ,, S.E.		
Mosside	1 ,, N.E.		
Bashaw	$1\frac{1}{2}$,, N.E.		
Kilcadzow	3 ,, E.		
Shelly Limestone		391 ,,	
Braidwood Gill	2 ,, S.		Limestone.
Nellfield Burn	2 ,, S.E.		

	Distance and direction from Carluke Church.	Stratigraphic position below the Ell coal.	Nature of strata.
Productus Limestone		397 fathoms.	
Braidwood Gill	2 miles S.		Limestone and shales.
Nellfield Burn	2 „ S.E.		Limestone and shales.
Near Yuildshields	2 „ E.		Limestone and shales.
Ironstone Beds		410 „	
Nellfield Burn	2 „ S.E.		Ironstone and shales.

The foregoing list embraces strata in descending order where Brachiopoda and other fossils have been found in Carluke parish, and for which I am indebted to a local inquirer, whose knowledge of the district and its localities has extended over thirty years.

Brockley	6 miles	S. of Lesmahago	Limestone and shale.
Coalburn	4 „	S. „	„
Brown Hill	2 „	S. „	„
Middleholm	2 „	S.W. „	„
Moat	3 „	E. „	„
Hall Hill	$3\frac{1}{2}$ „	N.E. „	„
Auchenbeg	3 „	S. „	„
Kersegill	$1\frac{1}{2}$ „	N. „	„
Birkwood	2 „	N. „	„
Dykehead	3 „	N.W. „	„
Auchenheath	3 „	N. „	Ironstone and shale.
Den	3 „	N. „	Limestone and shale.
Dalgow	3 „	W. „	„
Flat	5 „	N.E. „	„
Crossford	2 „	S. of Braidwood	„
Gallowhill	$\frac{3}{4}$ „	E. of Strathavon	„
Limekiln Burn	$3\frac{1}{2}$ „	S.W. of Hamilton	Limestone.
Boghead	$3\frac{1}{2}$ „	S.W. of Hamilton	Limestone.
Auchentibber	$1\frac{1}{2}$ „	S.W. of High Blantyre	Limestone and shale.
Calderside Mines	2 „	S.W. „	
Brankamhall, Calderwood	$1\frac{1}{4}$ „	S. of East Kilbride	
Capelrig, Calderwood	1 „	S. „	
Limekilns, near East Kilbride			
Lickprivick	2 „	S.W. „	Limestone and shale.
Hermyres	2 „	W. „	
Thorntonhall	$2\frac{1}{2}$ „	W. „	
Parliamentary Road, corner of North Frederick Street, Glasgow (exposed during building operation in 1857)			Calcareous sandstone and shale.
Robroyston	2 „	N.E. of Glasgow	Old shale heaps.

Bedlay	6 to 7 miles N.E. of Glasgow	Limestone and shale.
Chryston . . .		
Garnkirk . . .		
Moodiesburn . . .		

Shales above limestone at Bishopbriggs, 3 miles N. of Glasgow.

The Lanarkshire localities have been carefully explored by Mr. J. Armstrong, Mr. J. Thomson, Mr. R. Slimon, Mr. Young, Mr. Bennie, &c., and comprise likewise those quoted by David Ure in his 'History of East Kelbride,' &c.

STIRLINGSHIRE.

Calmy limestone and shales, Balquarhage, 2 miles S.S.E. of Lennoxtown.
Corrieburn, on Campsie Hill, 4 miles N.E. of Kirkintilloch—limestone, ironstone, and shales.
Dark gray limestone and shale, 22 fathoms above Campsie main limestone, South Hill pits, and Barraston, near Lennoxtown.
Shales above Campsie main limestone, Schiliengow, near Lennoxtown.
Campsie main limestone, Schiliengow, Ferrot's and Gloratt quarries, North Hill, and Alum Work mines and Craigend Muir, South Hill, all near Lennoxtown.
Shelly limestone, ironstone, and shale, Balgrochan Burn, $\frac{1}{2}$ mile N. of Lennoxtown.
Limestone and shale, Mill Burn, near Lennoxtown.
Ironstone and shale, Balglass Burn, near Lennoxtown.
Limestone, ironstone, and shales, Craigenglen and Glenwine, 2 miles S.W. of Lennoxtown.

In the foregoing list are enumerated all the localities from which Brachiopoda have been obtained in the Campsie district.

Banton	2 miles E. of Kilsyth	Limestone.
Murray's Hall . . .	S.W. of Stirling.	

All the Stirlingshire localities have been minutely examined by Mr. Young.

DUMBARTONSHIRE.

Castlecary . . .	Near Cumbernauld	Limestone and shale.
Netherwood . . .		
Duntocher . . .	$9\frac{1}{2}$ miles N.W. of Glasgow	Bed of limestone and shale, near sandstone quarry.

RENFREWSHIRE.

Howood	4 miles W. of Paisley	Limestone and shale.
Wauk Mill Glen . . .	Barrhead	„
Hurlet	$7\frac{1}{2}$ miles S.W. of Glasgow	„
Orchard	1 „ E. of Thornliebank	„

Davieland quarry	Near Thornliebank	Limestone and shale.
Arden quarry	,,	,,

These as well as the Ayrshire localities have been carefully searched by Mr. J. Thomson, Mr. J. Armstrong, and others.

AYRSHIRE.

West Broadstone	1 mile S. of Beith	Limestone and shale.
Roughwood	Near Beith	,,
Auchenskeigh	2 miles S. of Dalry	,,
Highfield Quarry	1 ,, N.E. ,,	,,
Linn Spout	Near Dalry	,,
Bowertrapping	,,	,,
Gateside	Near Beith	,,
Goldcraig	1 mile E. of Kilwinning	,,
Monkredding	1½ ,, ,,	,,
Hallerhirst	Near Stevenston	,,
Craigie	Near Kilmarnock	,,
Cessnock	1 mile S.E. of Galston	,,
Alton	2 miles N. ,,	
Moscow	3 ,, N. ,,	
Nethernewton	3 ,, N.E. ,,	
Hyndberry Bank	2 ,, N.E. ,,	
Meadowfoot	5 ,, E. of Darvel near Drumclog	
Gainford	2½ ,, E. of Stewarton	
Bruntland	1 ,, E. of Fenwick	
Mulloch Hill	New Dailly	

EDINBURGHSHIRE.

Gilmerton, near Edinburgh.
Wardie, ,,
Dryden, 6 miles S. of Edinburgh.
Carlops, 14 miles S. ,,
Joppa, near Portobello.
Roman Camp, near Dalkeith.
Cousland.
Magazine, 6 miles S.E. of Dalkeith.
Esperston, 2 miles S.E. of Temple.

Crichton Dean, Crichton Castle.
Penicuick.
Cornton, near Penicuick.
Mount Lothian, 3 miles S.E. of Penicuick.
Leven Seat, Addiewell, Scola Burn, Baad's Mill, S.W. of West Calder.

PEEBLESSHIRE.

Bents.
Lamancha.

Whim.
Whitfield.

Haddingtonshire.

Prestonpans.
Aberlady.
Longniddry.
Jerusalem.
Salton.
Kidlaw.
The Vaults, E. of Dunbar.
Skateraw ,,
Cat Craig ,,
East Barns ,,
Saughton, 4 miles W. of Haddington.

Linlithgowshire.

Kinniel, Dykeneuk, Craigenbuck, } W. of Borrowstownness.
Tod's Mill, River Avon.
Caribber, S.W. of Linlithgow.
Bowden Hill, S.W. ,,
Bathgate Hills.
Balbardie, near Bathgate.
Blackburn, S.E. ,,
Breichwater, above Breichdyke.
Hillhouse, 1 mile S. of Linlithgow.
Tartraven, 3 miles S.E. ,,

Fifeshire.

Ladedda, Wilkieston, Winthank, } 3 miles S.W. of St. Andrew's.
Craig Hartle, near St. Andrew's.
Craighall, Cult's Hill, Forthar, } 3 miles S.W. of Cupar.
St. Monance, 3 miles W. of Anstruther.
Strathkenny, St. Andrew's.
Dumbarnie, near Largo.
Chapel, Bogie, } Near Kirkcaldy.
Inverteil, Seafield, } Near Kirkcaldy.
Sunnybank, N. of Inverkeithing.
Parkend, N.E. ,,
Brucefield, S.E. of Dunfermline.
Rescobie, N. ,,
Duloch, E. ,,
Charlestown.
Rosyth, W. of the Castle.
Crombie Point.
Bucklyre, N. of Aberdour.

Berwickshire.

Cove at Cockburnspath.
Marshall Meadows, 3 miles N. of Berwick.
Coast between Lammerton and Berwick.

Dumfriesshire.

Closeburn.
Hollows, 4 miles S. of Langholm.

Kircudbrightshire.

Coast of Arbigland, Parish of Kirkbean.

This locality has been explored by Mr. John Steven, of Glasgow.

Buteshire.

Corrie, Arran.
Salt Pans.

For much information relative to the localities of the last nine Counties, I am indebted to Mr. Geikie, Mr. Page, Mr. Tate, Prof. Ramsay, Mr. Fraser, the late Dr. Fleming, and

H. Miller; as well as to Sir R. Murchison, and Mr. Salter, who have kindly allowed me access to the lists and specimens assembled during the survey of part of Scotland.

IRELAND.

In Ireland thirty counties have afforded about seventy-nine species, and is, next to England, the portion of Great Britain which has hitherto produced the largest number of species. It is possible that a few of these seventy-nine will turn out, when better known, to be synonyms, and that a few others may occur; but all my researches and efforts, as well as those of several friends in Ireland, have not hitherto succeeded in detecting a larger number, and I have already given my reasons why so many of those recorded in the 'Synopsis' must be rejected.

The portion of my table devoted to Irish species is founded on a personal examination of the specimens collected during many years by Mr. Kelly and others for Sir R. Griffith, and from which Prof. M'Coy's 'Synopsis of the Characters of the Carboniferous Fossils of Ireland' (1844) originated. I have also seen General Portlock's specimens, now forming part of the Museum of Practical Geology in London, and have examined many other specimens from various Irish private collections, as well as from the Geological Survey of Ireland, in addition to a small series in my own possession. It is, however, to Mr. Kelly, and to Mr. Joseph Wright, of Cork, that the distribution of the species in the larger number of the Irish counties is mainly due, as it is to them that I am indebted for most of the information and specimens I possess. As it is the case with England, some of the Irish counties have been more carefully searched than others; thus, for example, those of Dublin, Kildare, and Cork, have hitherto afforded the largest number of species. I have also availed myself of much information contained in Mr. Kelly's valuable paper 'On Localities of Fossils of the Carboniferous Limestone of Ireland,' 1855, and in the explanations of the Geological Survey of Ireland, No. 102, 122, 197, 198, and 153. Mr. Kelly divides the Carboniferous system of Ireland into—1, Old Red Sandstone; 2, Calciferous Slate; 3, Limestone; 4, Coal. I have, however, elsewhere objected to the term *Old* Red Sandstone being made use of for a division of the Carboniferous system, as it is evident that the term *Old* Red Sandstone cannot be retained or made use of to designate at the same time a Silurian, Devonian, and Carboniferous rock; the term *Old Red Sandstone* being now retained for a Devonian rock older than the Irish Red and Yellow Sandstone, which constitute the first or lowest division of the system. These Irish Sandstones, at Kildress and elsewhere, are full of Carboniferous, and not Devonian fossils; the same species, occurring in the Calciferous Slates, Carboniferous Limestone, and Shales. I have, therefore, suggested that geologists should drop the term "old" in their subdivisions of the Carboniferous group, and distinguish their lowest or first division by the designation of—1, *Lower*

Carboniferous Red and Yellow Sandstone. Mr. Kelly has, moreover, informed me, that in Ireland this red rock is not that which predominates, that it averages about one thousand feet in thickness, and is not much exposed, being usually covered with Limestone, except at the outcrop; that the 2nd, or Calciferous Slate, is not considerable in thickness, and that, in the best developed places (Clonea and Dungarvan), half of it is made up of bands of Limestone, the other half Calcareous Slate. The fossils in both he states to be inseparable, so that the Calciferous Slate and Mountain Limestone might be considered as one division, but that it is, perhaps, more correct, as a lithological distinction, to separate them into two. The Carboniferous, or Hibernian Limestone, is fifty feet thick at Drumquin, in Tyrone, and about 1500 feet thick at Black Head, in Clare; it occupies about 20,000 square miles in Ireland; while the coal measures are 2000 feet or more. Such are Mr. Kelly's views relative to the subdivisions of the Carboniferous system in Ireland. The great bulk of the specific forms among the Brachiopoda are found in the Calciferous Slates and Mountain Limestone, but few species occurring in the Red and Yellow Sandstones, or in the Coal measures. I include, also, in the Carboniferous Limestone, those bands of Limestone south of the Blackwater River, such as those of Cork, which have a strong cleavage (the fossils they contain being usually much contorted). I do so because the fifty-eight species of Brachiopoda, discovered in them by Mr. J. Wright and other geologists, are all the same as those common and characteristic to the Carboniferous Limestone of other parts of Ireland, as well as of England, Scotland, and the Continent generally, and which will be found enumerated, after careful identification, in the column of the table devoted to the county of Cork. With these preliminary observations I will now give the list of localities drawn up for this Monograph by Mr. Kelly; Mr. Joseph Wright having added those of Cork and from some other counties with which he was acquainted.

County of Armagh.—Annahugh (Limestone), six miles north-east of Armagh; Armagh, about the town; Ballygasey, four miles north of Armagh; Benburb, six miles north-west of Armagh; Calragh, five miles north-west of Armagh; Down, a quarter of a mile south-west of the town; Drummanmore, one mile north-east of Armagh; Kilmore, six miles north-east of Armagh; Tullyard, one mile north of Armagh. (Carboniferous Limestone in all these localities.)

Cork.—Little Island, four miles east of Cork; Windmill quarry is situated at the southern extremity of Cork; Midleton, thirteen miles east of Cork; Blackrock, two miles east of Cork; Carrigtwohill, eight miles east of Cork; Rafeen, five miles south-east of Cork; Mallow, on the River Blackwater; Glounthane, four miles east of Cork; Carrigaline, six miles south-east of Cork; Ballywalter, two miles north of Castletownroche; Castletownroche, eight miles north-east of Mallow; Streamhill, three miles north of Doneraile; Ringaskiddy, eight miles south-east of Cork; Fort William, one

mile and a half south-west of Doneraile; Annagh, four miles south-west of Charleville; Araglin Bridge, two miles north-east of Fermoy (the rock is yellowish sandstone); Banteer, three miles south of Kanturk; Castlecreagh, one mile east of Doneraile; Doneraile town stands on Fossiliferous limestone; Tankardstown, six miles north-east of Doneraile. These localites are almost all in limestone.

Carlow.—Bannaghagole, two miles west of Leighlinbridge (fossils abundant in limestone, covered by the coal rocks of Castlecomer); Old Leighlin, two miles west of Leighlinbridge (the limestone occurs here, and at its junction with the overlying Millstone grits of the Castlecomer district fossils are numerous, and some beautiful casts are found in old excavations); Raheendoran, four miles south-west of Carlow (limestone).

Clare.—Clifden, two miles west of Corofin (Millstone grit); Cloonlara, three miles north-east of Limerick; Kilmacduagh, five miles south-west of Gort (limestone); Moymore, seven miles east of Ennis; Scariff, eight miles north-west of Kilaloe.

Cavan.—Aghbay, one mile and a quarter south-west of Swanlinbar Village; Alteen, one mile north-west of Swanlinbar (limestone and shale); Ballyconnel, four miles west of Belturbet; Clonkeiffy, five miles south-west of Virgina; Countenan, one mile north-west of Stradone (arenaceous limestone); Kilcar, two miles south-west of Belturbet (Killeshandra limestone); Laragh, one mile north of Stradone; Swellan, one mile east of Cavan.

Dublin.—Ballintree, one mile north of Rush; Ballykea, two miles south of Skerries; Curkeen, two miles south of Skerries; Drumslattery, two miles south of Skerries; Howth, nine miles east of Dublin; Lane, two miles south-east of Skerries Malahide, shore very fossiliferous; Milverton, one mile south-west of Skerries; Oldtown, two miles north-west of Swords; Poulscadden joins the village of Howth; Salmon, three miles south of Balbriggan; St. Douloughs, five miles north-east of Dublin.

Donegal.—Abbeylands, one mile north-west of Ballyshannon (*Orthis Michelini* occurs here, along with *Strept. crenistria,* four inches in diameter); Ardloughill, two miles south-east of Ballyshannon; Ballybodonnel, ten miles west of Donegal; Bruckless, one mile north of Dunkineely; Bundoran, three miles south-west of Ballyshannon; Doorin, seven miles west of Donegal; Dunkineely, a village ten miles west of Donegal; Finner, three miles south-west of Ballyshannon; Greaghs, three miles south-east of the town of Donegal; Killoghtee, one mile south of Dunkineely; Lisnapaste, five miles south of Donegal; Rahans Bay, one

mile south-west of Dunkineely; Spierstown, two miles east of Donegal; St. John's Point, fourteen miles north-west of Donegal; Tinnycahill, two miles east of Donegal.

Down.—Castle Espie, two miles south-east of Comber; Cultra, five miles north-east of Belfast.

Fermanagh.—Ardatrave, two miles south-west of Kesh; Agharainy, one mile south of Kesh; Belmore Mountain, six miles south-west of Enniskillen; Boa Island, in north end of Lough Erne; Bohevny, one mile north-east of Church Hill; Bunaninver, three miles south of Kesh; Carn, three miles south-east of Kesh; Carrickoughter, two miles north-west of Kesh; Carrowntreemall, ten miles south-west of Enniskillen; Clareview, two miles south-west of Kesh; Cleenishgarve, an island in North Lough Erne; Corlave, three miles north-west of Kesh; Cornagrade, half a mile east of Enniskillen; Crevenish, one mile south-east of Kesh; Deerpark, two miles south-east of Kesh; Derrygonelly, eleven miles north-west from Enniskillen; Derrynacapple, four miles north-east of Kesh; Ederney, two miles east of Kesh; Kesh, twelve miles north-east of Enniskillen; Killycloghy, two miles south-west of Lisbellaw; Knockninny, ten miles south-east of Enniskillen; Leam, two miles east of Tempo; Ring, two miles north-east of Enniskillen; Shean, a mile north of Church Hill.

Galway.—Athenry, ten miles east of Galway; Ballinfoyle, one mile north-east of Galway; Ballyhanry, five miles west of Portumna; Caheratrim, three miles south-west of Loughrea; Cappaghmoyle, four miles north-east of Athenry; Carrowntobber, two miles north-east of Athenry (Cong limestone all round the town); Cregganore, six miles south-west of Loughrea.

Kerry.—Ballymacelligot, three miles east of Tralee; Castle Island, quarries round the town; Currens, six miles east of Tralee; near Farmer's Bridge; Castlemaine, nine miles south of Tralee.

Kildare.—Ardclough, eight miles west of Dublin, near the Grand Canal; Boston, six miles north of Kildare; Millicent, four miles north of Naas.

King's County.—Banagher, quarries about the town.

Limerick.—Kilmallock, quarries about the town; Croagh, three miles north-east of Rathkeale; Kyletaun, one mile north of Rathkeale; Blossomhill, one and a half miles north-east of Rathkeale; Ballingarrane, two miles north of Rathkeale,

Doohylebeg, two miles north-east of Rathkeale; Stoneville, one mile north-west of Rathkeale; Fanningstown, three miles north-west of Croom; Caherass, one mile north-west of Croom; Rathkeale, all about the town; Adare, ten miles south-west of Limerick; Castleconnel, seven miles north-east of Limerick.

Louth.—Carlingford, quarries about the town; Kilcurry, four miles north-west of Dundalk; Knockagh, three miles north-west of Dundalk.

Longford.—Ballymahon, quarries about the town; Carrickboy, five miles north-east of Ballymahon; Carrickduff, two miles north of Granard; Granard has fossils in the rocks about it; Kilcommock, three miles north-west of Ballymahon; Mullawornia, two miles north-west of Ballymahon; Rathcline, two miles south of Lanesborough; Shrule, four miles north of Ballymahon; Tirlicken, three miles north-west of Ballymahon.

Leitrim.—Aghamore, five miles south-west of Ballyshannon; Blacklion, twelve miles west of Enniskillen; Manorhamilton; Mohill, a small town on black slate fossiliferous; Ussaun, half a mile west of Mohill.

Meath.—Altmush, two miles north of Nobber; Ardagh, five miles south of Carrickmacross; Ballyhoe, five miles south of Carrickmacross; Balsitric, three miles east of Nobber; Castletown, four miles south of Trim; Cregg, two miles north of Nobber; Cruicetown, two miles west of Nobber; Cusackstown, six miles south-east of Navan; Flemingstown, six miles west of Balbriggan; Horath, three miles north of Kells; Laracor, two miles south of Trim; Mullaghfin, two miles west of Duleek; Rathgillen, two miles north of Nobber; Crusserath, three miles south of Drogheda.

Mayo.—Ballina, quarries about the town; Ballinglen, six miles north-west of Killala; Bunatrahir, one mile north-west of Ballycastle; Crosspatrick, one mile south-east of Killala; Cuilmore, three miles east of Claremorris; Kilbride, two miles north-east of Bally Castle; Kilcummin, five miles north-west of Killala; Killogunra, two miles south-west of Killala; Killybrone, one mile north-west of Killala; Larganmore, fourteen miles west of Crossmolina.

Monaghan.—Clonturk, three miles south-east of Carrickmacross; Dundonagh, six miles north of Monaghan; Killyrean Upper, two miles north-east of Emyvale; Leck, two miles north of Glasslough; Monaghan Town, quarries about it; Mullaghboy, two miles east of Emyvale; Mullaliss, two miles east of Emyvale.

Queen's County.—Aghafin, one mile south-west of Castletown; Burris, two miles north-east of Maryborough; Ringstown, one mile north-east of Mountrath; Roundwood, three miles north-west of Mountrath; Tinnekill, three miles north-east of Mountmelick.

Roscommon.—Carrownanalt, two miles north-east of Keadue; Cartronaglogh, half a mile north of Keadue; Cleen, four miles north-east of Boyle; Drumdoe, four miles north of Boyle; Grangemore, three miles south-west of Boyle; Killukin, one mile south-west of Carrickonshannon; Lacken, three miles south-east of Athleague; Lisardrea, two miles south-west of Boyle; Moore, three miles east of Ballinasloe; Rathmoyle, five miles south of French Park; Termon joins Boyle.

Sligo.—Ballinafad, five miles north of Boyle; Ballymeeny, two miles south-east of Easky; Bunowna, in the river and quarries about Easky; Carrowmably, four miles south-east of Easky; Carrowmacrory, six miles east of Easky; Carrowmore, four miles south-west of Coolaney; Cashelboy, twelve miles west of Sligo; Culleenamore, five miles west of Sligo; Kilglass, eight miles north of Ballina; Magheranore, two miles east of Tobercorry; Streedagh, ten miles north-west of Sligo.

Tipperary.—Carrigahorig, three miles south-east of Portumna; Nenagh, in limestone quarries about the town; Clonmel, limestone in the vicinity of the town.

Tyrone.—Aghintain, two miles west of Clogher; Aghnaglogh, two miles north-west of Clogher; Annaghilla, three miles south-west of Ballygawley; Ballymacan, two miles south-west of Clogher; Cavansallagh, two miles north-west of Drumquin; Claraghmore, one mile north-east of Drumquin; Clare, half a mile east of Cookstown; Cookstown, the town stands on limestone; Derryloran joins Cookstown; Donaghrisk, two miles south-east of Cookstown; Drumowen, two miles west of Drumquin; Drumscraw, one mile south-west of Drumquin; Edenasop, five miles south-west of Castlederg; Kildress, two miles west of Cookstown; Killymeal, half a mile east of Dungannon; Knockonny, half a mile north of Ballygawley; Lackagh, one mile west of Drumquin; Lismore, half a mile south-west of Clogher; Magherenny, one mile south-east of Drumquin; Mullaghtinny, a mile east of Clogher; Rahoran, two miles north of Fivemiletown.

Waterford.—Ardoe, five miles east of Youghal; Ballinacourty, three miles east of Dungarvan; Ballyduff, two miles west of Dungarvan; Clonea, three miles north-east of Dungarvan; Curragh, one mile north of Ardmore; Killinamack, three miles south-west of Clonmel; Whiting Bay, two miles east of Youghal.

Westmeath.—Cornadowagh, seven miles west of Ballymahon; Athlone, two miles south-east of the town.

Wexford.—Hook Head, on the east side of Waterford Harbour; Drinagh, one mile south of Wexford.

Killenny.—Dunkit, three miles north of Waterford; Kilkenny; marble quarries.

Antrim.—Tornaroan, one mile and a half east of Ballycastle, on the shore at highwater mark.

CARBONIFEROUS BRACHIOPODA BEYOND THE LIMITS OF GREAT BRITAIN.

Ninety-three of the species mentioned in my tables have been found in various countries beyond the limits of Great Britain, and perhaps a larger number will be obtained after a more extended search, for the species of many distant regions, and of even European countries (Belgium excepted), are but imperfectly known. It is to Prof. de Koninck's admirable researches that we are mainly indebted for our knowledge of the palæontological richness of the Carboniferous rocks of Belgium, which he has ably elaborated during many years. The number of Carboniferous Brachiopoda discovered by our friend in his country but slightly exceed (?) those hitherto found in Great Britain. Mr. Edward Dupont has also assembled from the neighbourhood of Dinant nearly ninety species of Brachiopoda,[1] and which, with very few exceptions, are specifically the same as those which occur in Great Britain, so that while Belgium contains some forms hitherto unknown to our strata, Great Britain numbers likewise a few species not hitherto discovered in Belgium.

The French Carboniferous species have not yet been studied in a satisfactory manner, but there, as in Russia and in other parts of Europe, many of our British species occur, along with a few forms special to the district.

Having recently examined and described the Carboniferous Brachiopoda of the Punjab (India),[2] I found that out of twenty-eight species, at least thirteen were common to

[1] "Notice sur les Gites de fossiles du Calcaire des bandes Carbonifères de Florennes et de Dinant," 'Bulletins de l'Académie Royale de Belgique,' 2d ser., vol. xii, No. 12, 1861.

Great credit is due to this young naturalist, who by dint of labour and perseverance has, within a comparatively short period, assembled upwards of ten thousand specimens representing some five hundred species from the Carboniferous rocks of his district.

[2] 'Quarterly Journal of the Geol. Soc.,' vol. xviii, p. 25, 1862.

European rocks of the same period, although several of these have in India attained larger proportions; and among which we may mention, *Athyris Royssii*, *A. subtilita*, *Retzia radialis*, var. *Grandicosta*, *Spirifera striata*, *Sp. lineata*, *S. octoplicata*, *Rh. pleurodon*, *Orthis resupinata*, *Strept. crenistria*, *Prod. striatus*, *P. semireticulatus*, *P. longispinus;* and a further search in these distant regions will, no doubt, bring to light a larger number of the common species.

The Australian and Tasmanian Carboniferous rocks have also afforded their quota of common species, for, although the forms from these continents have not yet been sufficiently examined, still, from a glance I have given to collections sent home from Bundaba and Port Stephen in Australia, as well as from Van Diemen's Land, I have already been able to recognise *T. hastata*, *Sp. striata*, *Sp. glabra*, *S. lineata*, *Rh. pleurodon*, *Strept. crenistria*, *Orthis Michelini*, *Prod. Cora*, &c. If again, and by a rapid stride, we should find ourselves cast on some of the Spitzbergian frozen coasts, we would there pick up several of our common species, such as *Sp. Octoplicatus*, *St. crenistria*, *Prod. semireticulatus*, *P. costatus*, &c., along with other forms not known in Britain, for we cannot expect to find all the same species repeated and assembled everywhere; some forms were more localized than others. Even in Great Britain, we find certain species in England that do not appear to have existed either in Scotland or Ireland, and *vice versâ;* it is not, therefore, surprising that in other countries the same order of things should prevail. If we cast a glance at the prodigiously extended Carboniferous regions of America, we shall there also find a vast per-centage of species identical with our own, but which, in many cases, have received new names from our American cousins. Possessing an extensive series of American Carboniferous species, for which I am indebted to the kindness of Mr. Worthen, as well as to that of some other American geologists, and having compared these with our British specimens, I may mention, from among others not yet sufficiently studied, the following few as being identical with our own—*T. sacculus*, *A. ambigua*, *A. subtilita*, *A. plano-sulcata*, *A. lamellosa*, *A. Royssii*, *Retzia radialis*, *Sp. striata*, *S. trigonalis*, *Sp. lineata*, *Sp. Urii*, *S. octoplicata*, *Rh. pleurodon*, *Orthis Michelini*, *Strept. crenistria*, *Prod. Cora*, *P. punctatus*, *P. longispinus*, *P. semireticulatus*, *P. scabriculus*, *P. costatus*, *Crania quadrata*, *Discina nitida*, *Lingula mytiloides*, &c., and I entirely concur with the observation made by Sir R. Murchison, at page 324 of his celebrated "Siluria," that "The specific identity of so many of the Brachiopoda of the marine or Lower Carboniferous rocks situated at enormous distances in latitude from one another (*e. g.* from the Arctic circle to within a few degrees of the Equator), is an additional and striking proof of the general uniformity of temperature and condition during this epoch."

I must now conclude this lengthened inquiry into the history of British Carboniferous species, but sincerely hope that local observers will continue the study I have so far sketched out, for much remains still to be achieved, which time and search alone can accomplish.

APPENDIX

TO THE

CARBONIFEROUS AND PERMIAN MONOGRAPHS.

Plate LIV.

It is to be regretted that the series of Monographs on British Fossil Brachiopoda, as well as those relating to other classes, published by the Palæontographical Society, had not commenced with the species of the Silurian system, and progressed regularly upwards to the Tertiary period. By such a mode of proceeding important advantages would have been obtained, from the possibility of tracing with more certainty and regularity the recurrence of certain species, and thus have obviated the unfortunate necessity of occasional alterations and repetitions to the parts already printed. The recurrence of certain species in one or more systems is a subject of much importance, and is now an acknowledged fact, but while there appears in some minds a manifest disinclination to admit such a thing as possible, others have exaggerated the occurrence, and thus done more harm than good. It would certainly be very agreeable and advantageous were there no recurrent species, and that all the forms of each system or zone were characteristic to it; but such not being the case, we must unavoidably abandon preconceived ideas, and endeavour to carefully trace the recurrence. I will not at present allude to those species which are common to the Devonian and Carboniferous systems, as I have not yet critically examined the Devonian forms, and shall therefore reserve what I might have to say upon the subject until a future period, but it will be desirable to briefly refer once more to those that appear to be common to the Carboniferous and Permian epochs.

Several observers, among whom we may mention M. de Verneuil, Profs. King and Morris, Messrs. Howse, Kirkby, and myself, have more than once alluded to the strong resemblance—nay, identity—of certain Carboniferous and Permian species,[1] but

[1] My observations upon the recurrent forms in question will be found in various parts of my Carboniferous Monograph, as well as in some numbers of 'The Geologist.' Mr. Kirkby's views are incorporated in his excellent paper, "On the recurrence of *Lingula Credneri*," &c., 'Journal of the Geological Society,' for March, 1858.

as Prof. King appears to question the correctness of some of our statements[1] it will be desirable to represent, side by side (in Pl. LIV) those forms that appear to be common to the Carboniferous and Permian deposits of our island.

Carboniferous Names.	*Permian Names.*
Terebratula sacculus, *Martin*, sp. 1809. *Dav.*, pl. liv, fig. 5.	Terebratula sufflata, *Schlotheim*, sp. 1816. *Dav.*, pl. liv, fig. 6.

The identity of the Carboniferous and Permian shell is so complete that Schlotheim's denomination will require to be located among the synonyms of *S. sacculus.* Prof. King admits this identity.

Terebratula hastata, *Sow.*, sp. 1824. *Dav.*, pl. liv, figs. 1 and 3.	? Terebratula elongata, *Schlotheim*, sp. 1816. *Dav.*, pl. liv, figs. 2 and 4.

It is an unquestionable fact that many specimens of the Carboniferous and Permian shells are undistinguishable, as will be at once perceived by a glance at the specimens or figures selected from among others for illustration; but I must confess that more difference is shown between the greater number of typical *T. hastata* and *T. elongata* than is here represented, the strong resemblance being the exception, and more especially observable between that variety of *T. hastata* we have termed *Gillingensis* and *T. elongata* proper. It must also be observed, that it is often impossible to distinguish certain examples of *T. sacculus* and *T. hastata,* which appear to merge the one into the other, and the same may be said with reference to *T. sufflata* and *T. elongata,* and this proves how intimately connected are all the British forms of Carboniferous and Permian Terebratula. The subject relating to the identity of *T. hastata* and *T. elongata* may therefore, for the present, remain an open question.

Athyris Royssii, *L'Eveillé*, sp. 1835. *Dav.*, pl. liv, fig. 8.	Athyris pectinifera, *J. de C. Sow.*, 1840. *Dav.*, pl. liv, fig. 9.

M. De Verneuil and Prof. King have both alluded to the resemblance which appears to exist between these shells; and although I thought at one time that sufficient differences might perhaps be established between them, I am now very much afraid that they will have to be merged into a single species, and, if so, Sowerby's denomination would require to give way to that of L'Eveillé. *A. pectinifera* does not appear to have attained the large proportions of a full grown *A. Royssii,* but size alone cannot be made use of as a distinguishing character between species which otherwise resemble each other, and in the

[1] King, "On certain species of Permian Shells said to be found in Carboniferous Rocks," 'Edinburgh Philosophical Journal,' vol. xiv, new series, p. 37, &c., 1861, and vol. xv, April, 1862.

present case more especially, for Permian shells as a rule are of smaller size than Carboniferous ones.

Carboniferous Names.	*Permian Names.*
SPIRIFERA URII, *Fleming*, sp. 1828. *Dav.*, pl. liv, fig. 14.	SPIRIFERA CLANNYANA, *King*, sp. 1848. *Dav.*, pl. liv, fig. 15.

Prof. King denies the identity of these two shells, although allowing them to be closely related; but after having compared many examples of the Carboniferous and Permian species? neither Mr. Kirkby nor myself could perceive any valid specific difference between them.[1]

SPIRIFERINA OCTOPLICATA, *Sow.*, sp. 1827. *Dav.*, pl. liv, figs. 10 and 12.	SPIRIFERINA CRISTATA, *Schloth.*, sp. 1816. *Dav.*, pl. liv, figs. 11 and 13.

It appears to me, as well as to my friend Mr. Kirkby, that there cannot exist a doubt as to these shells belonging to a single species, for which Schlotheim's name should be preferred. None of the Permian examples that have come under our observation have attained the dimensions of certain full-grown Carboniferous specimens, but the general character in both is specifically the same.

CAMAROPHORIA CRUMENA, *Martin*, sp. 1809. *Dav.*, pl. liv, figs. 16, 17, 18.	CAMAROPHORIA SCHLOTHEIMI, *v. Buch*, sp. 1834. *Dav.*, pl. liv, fig. 19.

I feel satisfied that my identification of the Permian *C. Schlotheimi* with Martin's *Anomites crumena* is correct. Prof. King has admitted that the last-named shell is a *Camarophoria*, but believes it specifically different to *C. Schlotheimi*. I have, however, found Permian specimens agreeing very closely with Martin's imperfect figure, and am not acquainted with any other Carboniferous Camarophoria to which the Permian shell could be assimilated than the one we recognise as *crumena*. In *C. Schlotheimi* the mesial fold varies in width and elevation according to the number of ribs which ornament its surface, these varying usually from two to seven, and from one to six in the sinus, while in the Carboniferous shell the same differences are observable, as may be seen in figs. 3—9 of Pl. XXV. It is, therefore, evident that one of the two above-mentioned names will have to be erased, and as Martin's species possesses claims to priority, its name will have to be retained for the Permian as well as the Carboniferous specimens.

[1] The term *recurrent* has been applied by palæontologists to such species as occur in more than one formation or system of strata. In this sense I use it here. For instance, as I consider *Spirifera unguiculus*, Sow. of the Devonian, *Sp. Urii* of the Carboniferous, and *Sp. Clannyana*, king of the Permian system, to be same species, it is said to be recurrent, because it reappears or recurs in two distinct groups of strata after its first appearance in the Devonian system. The term also necessarily implies that the species *existed during the whole of the period* that is included between its first and last appearance.

CAMAROPHORIA RHOMBOIDEA, *Phillips*, sp. 1836. *Dav.*, pl. liv, figs. 20—22.

CAMAROPHORIA GLOBULINA, *Phillips*, sp. 1834. *Dav.*, pl. liv, figs. 23—25.

After a very attentive comparison of many specimens of these shells from the Carboniferous and Permian deposits, I cannot perceive the smallest distinguishing features; specimens of equal size resemble each other, as may be seen from my illustrations. The Carboniferous form, when full grown, has attained somewhat larger proportions than any I have observed from the Permian rocks. The term *globulina*, from having been first proposed, should be employed for both, and that of *rhomboidea* be placed among the synonyms.

Carboniferous Names.

DISCINA NITIDA, *Phillips*, sp. 1836. *Dav.*, pl. liv, fig. 26.

Permian Names.

DISCINA KONINCKII, *Geinitz*, 1848. *Dav.*, pl. liv, fig. 27.

Having examined and compared with much attention a number of Carboniferous and Permian specimens of these two so-termed species, I have come to the conclusion that there exists no specific difference between them, and that the term *nitida* will have to be made use of for the Permian shell. Many large and well-preserved specimens of the Permian *Discina* have been collected by Messrs. R. J. Manson, T. Parker, and E. Gower, in the compact Limestone of East Thickley, near Darlington, which are identically similar to others from the Carboniferous shales of Capel Rig in Lanarkshire; in all we could perceive the same contour, the same degrees of convexity and external sculpture.

LINGULA MYTILOIDES, *Sow.*, 1812. *Dav.*, pl. liv, figs. 28—31.

LINGULA CREDNERI, *Geinitz,* 1848. *Dav.*, pl. liv, figs. 32—34.

In his excellent paper (already quoted) Mr. Kirkby has satisfactorily proved that the Permian *Lingula Credneri* is found in the Carboniferous Rocks of England, a fact I can likewise attest from personal observation; but I must go a step further, by suggesting that the Permian Lingula is doubtfully distinguishable from Sowerby's *L. mytiloides,* which was likewise described from specimens obtained in the Carboniferous Shales of Wolsingham in the County of Durham. Mr. Tate is of opinion that *L. Credneri* is nothing more than a small variety or race of Sowerby's species.

It is not my present desire to enter into further details with reference to certain other species which may possibly be recurrent, but I cannot help mentioning that it is not quite certain that *Crania Kirkbyi* is distinct from *C. quadrata*, nor that *Spiriferina multiplicata* and *Sp. cristata* should be separated.

No new British Permian species of Brachiopoda has been discovered since the publication of my monograph, notwithstanding the most zealous researches of several naturalists. The compact Limestone of East Thickley, near Darlington, has been well searched by Messrs. R. T. Manson, T. Parker, and E. Gower, who have succeeded in procuring some excellent specimens of several species, such as *T. elongata, Cam. crumena, Sp. alata, Strept. pelargonatus, Stroph. Goldfussii, St. Morrisiana, Prod. horridus, Discina nitida* (D. Koninckii), and *Lingula mytiloides* or *Credneri*, so that the total number of Permian species of Brachiopoda occurring in Britain would, according to my views, not exceed sixteen or seventeen species, of which about half would be common to the Carboniferous and Permian periods.

As far, therefore, as the Brachiopoda are concerned, there exists a very intimate relationship between the Carboniferous and Permian species, and, as Messrs. Kirkby and R. Jones have already shown (and are ready to show still further), that species from other classes partake of the same identity. The Permian strata are, therefore, the natural continuation of the Great Carboniferous period, although it may be desirable to preserve the term Permian as originally given by the celebrated authors of 'Russia in Europe and the Ural Mountains Geographically Illustrated' to those strata which succeed the highest portion of the Carboniferous series. The term "Dyas" recently proposed as a substitute for that of "Permian" appears to me to be a very unfortunate idea, for, besides being incorrect in its meaning, it is, in reality, only a synonym, with which science is, alas, becoming so heavily burdened.

Strophalosia.

I am still of opinion that all our known British Permian *Strophalosias* should be referred to two species only.

1. *Strophalosia Goldfussii.*—Notwithstanding Prof. Geinitz's contrary opinion,[1] I believe that the shells referred to Münster's species in p. 39 of my Permian Monograph have been correctly identified, and am also of opinion that what Geinitz terms *St. excavata* from the Zechstein dolomite of Pössneck, and the typical *St. Goldfussii* from the Untere Zechstein of Trebnitz, near Gera, belong to the same species; but with this difference, that at the last-named place, the shell is found perfect with all its spines, while at Pössneck the specimens are either casts, or in a bad state of preservation, and it is in this decorticated condition that the shell is usually found in England.

2. The second species has been referred to *Strophalosia lamellosa* of Geinitz? but I am not so certain that this identification is strictly correct. Prof. Geinitz objects to the idea of uniting King's *St. Morrisiana* with his *St. lamellosa*, and considers the two as

[1] 'Dyas oder die Zechsteinformation und das Rothliegende,' part i, p. 96, 1861.

distinct species; while Messrs. Howse and Kirkby are still disposed to maintain the conclusions arrived at in p. 44 to 49 of my Permian Monograph. All our testiferous specimens of *St. Morrisiana* from Tunstall Hill, and casts from Humbleton, nowhere appear to have possessed that immense number of closely packed spines which are observable on the ventral valves of Geinitz's typical examples of *St. lamellosa* from Trebnitz; and indeed when I compare typical specimens of the same valve of *St. Goldfusii* and *St. lamellosa* from Trebnitz sent to me by Dr. Geinitz, I am at a loss to detect any difference between them; in both the spines appear equally numerous, and to be similarly implanted, so much so that it would not be possible to distinguish the two, had we not the smaller valve which in *St. Goldfusii* is covered with spines, while that of *St. lamellosa* is traversed by concentric laminæ of growth, usually individualised and ornamented with fine radiating striæ. In none of the British examples of *St. Morrisiana* that have come under my notice do we perceive that immense abundance of spines which are visible on the ventral valve of *St. lamellosa* from Trebnitz; on the contrary they are comparatively few, adpressed, and allowing one to perceive between them fine radiating striæ, while in the smaller valve we do not observe those prominent laminæ of growth visible in Geinitz's typical specimens of *St. lamellosa.* It is, therefore, uncertain whether we are quite justified while placing King's *St. Morrisiana* among the synonyms of *St. lamellosa.* The subject had better therefore, for the present be left an open question.

CRANIA KIRKBYI, *Dav.* Permian Mon., page 49; and Carb. Mon., Pl. liv, fig. 35—38.

When describing this species ? the exterior of the unattached or upper valve had alone been discovered, and although most of the specimens had their external surface roughly granulated, I have since been led to surmise that this appearance is perhaps due to the decomposition of parts of the shell, for in two or three more solid and better preserved specimens, the surface was almost smooth, or marked only by a few concentric lines of growth. The apex is more or less sub-marginal, while in some specimens it is almost central. It varies also much in shape, as do all *Crania* which live attached to submarine bodies. The interior of the upper valve has also been found by Mr. Kirkby, and of which illustrations will be found in Plate LIV of the present volume. So great is the resemblance of some specimens of this Permian Crania to others of *C. quadrata* from the Carboniferous Rocks of Scotland and Ireland, that I am somewhat undecided whether I should still retain the denomination applied to the Permian shell.

INDEX TO VOL. II.

(*Names in italic are synonyms, a ? before indicates probable synonyms or doubtful species.*)

FINIS.

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APPENDIX A.

Since the concluding pages as well as the index to this Monograph have been printed, some additional information has been obtained, which, I think, had better be recorded, and I must again apologise for being obliged to add a second appendix to this Monograph.

SCOTLAND.

During his summer excursions Mr. James Thomson, of Glasgow, was induced to examine some portions of Cantire or Kintyre, and in Tirfergus Glen, four and a half miles south-south-west from Campbeltown, he discovered Carboniferous Limestone, much altered by heat, and tilted up by an extensive outburst of trap on one side and of porphyry on the other.[1] In this Carboniferous rock thirty-five species of Mollusca have been discovered by Mr. Thomson, among which are the following Brachiopoda:—*Athyris ambigua, Sp. Urii, Rh. pleurodon, Strep. crenistria* and var. *radialis, Prod. latissimus, P. semireticulatus, P. costatus* and var. *muricatus, P. scabriculus, P. aculeatus, P. longispinus,* and *Chonetes Hardrensis*—thirteen species.

ENGLAND AND WALES.

Mr. D. C. Davies, of Oswestry, has obtained the following additional species in the north-west of Shropshire and in Denbighshire:[2]

[1] These beds, until the last few years, were thought to belong to the Liassic formation, but they have been tinted as Carboniferous in Prof. Nichols's new geological map of Scotland, as well as in that recently published by Sir R. Murchison and Mr. Geikie.

[2] Much information relative to the geology of these two counties will be found in Mr. D. C. Davies's interesting paper published in the 'Oswestry Advertiser and Montgomeryshire Mercury' for June 12th, 1861.

SHROPSHIRE.—*Ter. sacculus, Athyris expansa, A. globularis, A. plano-sulcata, Spirifera duplicicosta, S. glabra, S. ovalis, Sp. pinguis, Cyrtina carbonaria, Rh. acuminata, Camarophoria globulina, Strophomena analoga, Orthis resupinata, Prod. Cora, P. Keyserlingiana, P. punctatus, P. sulcatus, P. spinulosus, P. sinuatus, P. undatus, C. papilionacea, P. Llangollensis,* and an undetermined Lingula; so that instead of nineteen species (recorded at page 244), as many as forty species will have been discovered up to the present time in Shropshire.

DENBIGHSHIRE.—*Athyris globularis, A. expansa, A. plano-sulcata, Sp. octoplicata, Sp. pinguis, Rh. pugnus, Cam. globulina, Prod. aculeatus, P. fimbriatus, P. Keyserlingiana, P. latissimus, P. margaritaceus, P. scabriculus, P. sinuatus, P. Youngianus,* and *Ch. papilionacea,* have to be added to the twenty-four species recorded in our table, so that here also we have about the same number of species as we find recorded for Shropshire.

Fossiliferous localities in the North Wales belt of Carboniferous Limestone, counties Shropshire and Denbighshire, beginning at the southern termination, and proceeding north and west.—The Limestone consists of three principal divisions, viz., "Lower beds," a series of pale-coloured beds, separated by thin shales, and interstratified with several layers of red marl; "Middle beds," of gray crystalline Limestone; and "Upper beds," alternations of layers sometimes similar to the middle bed, and presenting a less splintering structure, and suitable for various architectural purposes. This list has been communicated to me by Mr. D. C. Davies, of Oswestry.

Localities, north-west Shropshire.	Characteristic Fossils and General Observations.[1]
Llanymynech, 6 miles S. of Oswestry	Lower beds: *Prod. Llangollensis, Ter. hastata, Prod. Cora.*
Porthywaen, 4½ miles S.W. of Oswestry	Lower beds: *P. Llangollensis, T. hastata, T. sacculus, Cyrtina carbonaria,* &c. Upper beds: *P. giganteus, P. latissimus, Spirifers,* &c.
Treflach, 3 miles W. of Oswestry	*Orthis Micheleni, Sp. octoplicata,* and nearly all the fossils peculiar to the upper beds; but the quarries, which are not much worked, have been diligently searched.
Pentregaer, 4 miles N.W. of Oswestry	*Chonetes papilionacea, C. Hardrensis, Spiriferinas,* and the smaller *Producta.*
Lawnt and Craig-y-rhiw, 3½ miles N.W. of Oswestry	*Chonetes Hardrensis, Prod. spinulosus,* and *P. longispinus.*
Selattyn Hills, W. of Lawnt, and N.N.W. of Oswestry	*Strept. crenistria, Prod. fimbriatus, P. latissimus, P. giganteus, Orthis Michelini, Athyris plano-sulcata,* &c.
Bronygarth, 2 miles W. of Chirk	Ordinary fossils.

[1] The foregoing remarks are confined to remains of Brachiopoda. Other fossils are found at most of the places mentioned.

Localities, Denbighshire.	Characteristic Fossils and General Observations.
Llangollen	In dark "upper beds," near Trevor, *Sp. trigonalis, S. duplicicosta,* &c. In the "middle beds," various *Producta* and *Spirifera,* but difficult to extract from the matrix. In the "lower beds," at the same place, small *Terebratulæ, Prod. Cora, P. semireticulatus,* var. *Martini.* In the "lowest beds," continued on towards Minera, *Prod. Llangollensis.* In the "topmost beds," extending towards the same place, *Athyris Royssii,* with abundance of various *Producta, P. fimbriatus, P. Martini, Sp. glabra, Rhynchonella,* &c.
Fron, between Chirk and Llangollen	
Trevor, near Llangollen	
Eglwseg Ridge, near Llangollen	
Head of the Vale of Clwyd, $\frac{1}{4}$ mile S. of Llomfour Chapel	*Prod. latissimus, Rh. pleurodon,* and the usual upper fossils.
Caergwrle Hills, between Wrexham and Molef	The common fossils of the upper beds.
Abergele, North Wales	*Prod. Cora, P. semireticulatus, C. papilionacea.* Best quarries are at Llysfaen.
Great Ormes Head, near Llandudno	Upper beds' usual fossils, in shale and débris of mine shafts, on surface of the cropping beds.
Slope S. and escarpment W. of telegraph	
Hafod, 2 miles W. of Corwen, N. Wales	An outlier. Beds correspond to those of the main belt; upper portion worked. *P. giganteus, P. latissimus, P. scabriculus, Spiriferidæ, Rhynchonella,* &c.

Derbyshire.—Add to the localities given at page 248, Low Fields, near Middleton, by Yolgrave.

Staffordshire.—Page 244, instead of seventy-eight species write eighty-five, and to the tables add *Athyris subtilita, Rhyn. Wettonensis,* Dav., *Streptorhynchus Kellii, Prod. Carringtoniana,* Dav., *Prod. Koninckiana,* De Verneuil.

Gloucestershire.—Add to the tables, *Chonetes Buchiana,* found by W. W. Stoddart near Bristol.

Rhynchonella Wettonensis, *Dav.* Plate LV, figs. 1—3.

Sp. Char. Shell transversely oval, wider than long; ventral valve more convex than the dorsal one, with a mesial fold of greater or lesser elevation, commencing at about the middle of the valve, and extending to the front; beak small, angular, but slightly produced, and incurved with a minute circular foramen, placed under its extremity. Dorsal valve moderately convex, with a sinus of greater or lesser depth, commencing close to the extremity of the umbone, and extending to the front, where it attains its greatest breadth and depth. Each valve is ornamented with small, radiating ribs or striæ, while numerous concentric lines of growth occur at irregular intervals on the surface of the valves. Interior unknown.

Average dimensions: length 8, width 11, depth 5 lines.

Obs. This Rhynchonella is at once distinguishable from all its congeners in the Carboniferous period on account of its peculiar shape and character, occasioned by the fold existing in the ventral valve and the sinus in the dorsal one. This arrangement is, however, known to exist in some Devonian, Jurassic, and Cretaceous Rhynchonellæ, but is not of common occurrence. In very young specimens the fold and sinus are but slightly marked, but they become very apparent and developed with age; the striæ also in some aged examples are hardly visible, but are well marked in the larger number of specimens.

This remarkable shell occurs by myriads in the Carboniferous Limestones at Narrowdale, in the parish of Allstonefield, not two miles from Dove, in Staffordshire, and is one of Mr. Carrington's most interesting discoveries.[1]

Productus Carringtoniana, *Dav.* Plate LV, fig. 5.

Sp. Char. Shell somewhat sub-orbicular or transversely semicircular, wider than long; hinge-line straight, and about as long as the width of the shell; ventral valve regularly and evenly convex; beak small, hardly produced beyond the hinge-line; ears small;

[1] In a letter dated 11th September, 1862, Mr. Carrington writes, "I had a fortunate find yesterday, having been quarrying for several days on a hill side to the depth of three feet, I arrived at a fault which originally had been an open cleft in the ocean bed. This bed had been filled with materials differing from the sides which bounded the cleft. The fossils were peculiar, consisting of thousands of closely packed specimens of *Lingula mytiloides*, *Discina nitida*, *Rhyn. Wettonensis* (Dav., n. sp.), *Productus Carringtoniana* (Dav., n. sp.), and of a large variety of *Spirifera Carlukiensis* (Dav.); and it would appear to me that the cleft had been perpendicular at the time of their existence, as it is now (?), and that the Brachiopoda must have been attached to its sides, as the great abundance of the specimens are found in a conglomerate of one inch or more all the way down. The small Spirifer occurs by myriads, and there are also some fine Pectens. In the limestone bounding the cleft we find *Prod. giganteus*, *P. striatus*, *Bellerophon*, *Nautilus*, &c."

surface entirely covered with tolerably regular, but more or less interrupted, sub-parallel, concentric ridges or wrinkles. Slender spines rise here and there from the surface of the ventral valve, and are more numerous on the ears. Dorsal valve moderately concave, and ornamented as in the opposite one.

Average dimensions: length 11, breadth 13 lines.

Obs. This Productus appears to be easily distinguishable from the other British Carboniferous species of the genus by its shape and sculpture, and I am supported in this view by Prof. de Koninck, to whom I submitted several specimens. None of the examples hitherto discovered by Mr. Carrington in the Narrowdale Cleft appears to have exceeded the dimensions given above, nor is it near so common as are *Rh. Wettonensis*, *Discina nitida*, and *Spirifer Carlukiensis*.

PRODUCTUS OR CHONETES COMOIDES, *Sow.* (p. 180).

While describing Sowerby's *Productus* (or *Chonetes*) *comoides*, I did not omit to refer to the several difficulties in the way of a satisfactory determination of this important species. I also mentioned that it had been questioned by certain palæontologists whether the shells (Pl. XLV, figs. 1—6) really belonged to Sowerby's species, and I gave the reasons why I had united them to *C. comoides*. Feeling, however, uncertain as to the correctness of this view, I requested Mr. D. C. Davies, of Oswestry, to kindly endeavour to search for more specimens of the Llangollen form (Pl. XLV, figs. 1—6; Pl. LV, figs. 9, 10), and especially for examples which would show the interior of the dorsal or smaller valve. Mr. Davies's success was complete in this respect, for at the close of the present summer he forwarded to me seven examples, of which one was a bivalve shell, and of which the valves could be separated (Pl. LV, figs. 9, 10). I felt much interested with this important discovery, for the interior of both valves proved in the most satisfactory manner that, notwithstanding the double area and strong articulating hinge-teeth, all the interior dispositions were those of *Productus*, and this has proved once more that *Chonetes*, *Aulosteges*, and *Strophalonia*, cannot be considered in any other light than sub-genera or section of *Productus*, and cannot claim generic value. Profiting by Prof. de Koninck's passage through London, I requested him to accompany me to the British Museum, in order that we might have a complete and minute examination of my Llangollen specimens with Sowerby's *Prod. comoides* and *P. hemisphæricus*.

The result of this examination was that we agreed completely that Sowerby's *P. hemisphæricus* was nothing more than a modification of age and specimen of Martin's *Productus giganteus*, as I had already stated it to be at p. 144 of this Monograph, and that it is specifically distinct from *P. comoides* as well as from the Llangollen form. Prof. de Koninck was, moreover, of opinion that the Llangollen form and *P. comoides* should be considered as distinct species, and adduced the much larger area, but slightly produced

beak beyond and above the cardinal edge, in *C. comoides*, as good specific distinctions whereby to separate it from the Llangollen shell, which possesses a very large, rounded beak and narrow area. I am not, however, quite so certain as to the absolute value of these characters in the forms under discussion; but as my distinguished friend so strongly advocates their separation, I will provisionally adhere to his view, and retain the term *comoides* for Sowerby's type, and that of *Llangollensis* for those represented in Pl. XLV, figs. 1—6; and Pl. LV, figs. 9, 10. They will be provisionally characterised in the following manner.

PRODUCTUS COMOIDES, *Sow.* Pl. XLV, fig. 7; Pl. XLVI, fig. 1; and Pl. LV, figs. 6, 7, 8.

Sp. Char. Shell large, transversely semicircular, concavo-convex; hinge-line straight, nearly as long as the width of the shell; ventral valve convex, very thick and wide; beak not protruding, or but very slightly so, beyond the level of the cardinal edge; fissure triangular and wide, partly arched over by a small pseudo-deltidium. Dorsal valve moderately concave, much thinner than the opposite one; area narrower than that of the ventral valve. Externally, both valves are covered with exceedingly fine and contiguous longitudinal striæ (four or five occupying the breadth of a single line). In the interior of the ventral valve (the only one known) and under the extremity of the beak there exists a pyriform muscular depression, which extends to about half the length of the valve (Pl. LV, fig. 8). This cavity is longitudinally divided into three almost equal portions; the central division contains, on a wide, flattened elevation, two pair of muscular impressions, situated one above the other. Those nearest to the extremity of the beak are due to the adductor (A), while the smaller, circular or oval pair (C) are supposed to have afforded another point of attachment to the same muscle. On either side of this central elevation are situated larger and deeper scars, which are due to the cardinal or divaricator muscle.

Dimensions variable; the largest specimen I have seen measured $3\frac{1}{2}$ inches in length by rather more than 6 inches in breadth, while Sowerby's typical specimen, when entire, must have measured 3 inches in length by somewhat less than $4\frac{1}{2}$ inches in width.

The grounds for locating this species in the sub-genus *Chonetes* have not been clearly made out. I will therefore leave it provisionally with *Productus*, as was originally done by Sowerby.

Sowerby states that his specimens (from which my description was taken) were from the wayboards between the limestone under the coal at Llangaveni, in Anglesea.

Productus Llangollensis, n. sp.? Plate XLV, figs. 1—6; Plate LV, figs. 9—10.

Sp. Char. Shell large, almost circular or transversely semicircular, concavo-convex; hinge-lines straight, usually shorter than the width of the shell. Ventral valve enormously thick and ponderous, very convex; beak rounded and much developed; area narrow, rarely exceeding a line in width; fissure triangular. Dorsal valve moderately concave; area very narrow; surface of both valves finely striated, three of these occupying the width of a line.

The ventral valve in some examples has attained nearly one inch in thickness. In the interior, on each side of the fissure, are two strong, projecting teeth, and under these commences a large, pyriform, muscular cavity, which extends to beyond half the length of the valve, and occupies about a third of its inner surface, the greatest breadth being situated towards the centre of the shell. In this depression three distinct pair of muscular impressions are visible, which are separated to a greater or lesser extent by three longitudinal ridges, the first central pair, or those situated nearest to the extremity of the beak, occupy the two sides of the central ridge, and which ridge is far more prominent or elevated than the other two; these impressions, which also extend sometimes a little beyond the limits of the central ridge, are due to the adductor (A); and still lower down, towards the centre of the valve, are two smaller, sharply defined, obliquely oval-shaped scars (c) (c in *Productus*, Pl. XXXVII, fig. 1), and which are supposed to be due to another attachment of the same muscle (?); while outside of these there exists a large, elongated impression, referable to the divaricator or cardinal muscle. It is somewhat singular that the small accessory adductor impression (c) had not been hitherto observed, either by M. de Koninck or by myself, but in the specimens recently found they are unmistakably defined.

If we now compare the interior of this valve with that of several species of *Productus*, we shall find that, excepting the dental processes, the muscular impressions would agree in all essential conditions with those of *Productus*. The relative position of the adductor and divaricator impressions varies somewhat in different species of the genus, as we have already described; thus, in *P. giganteus*, *P. longispinus*, &c., the divaricators are situated immediately *under* and outside of the adductor, while in *P. pustulosus*, *P. humerosus*, &c., the adductor is located between the two divaricator impressions, as in the case of *P. comoides*.

In the interior of the *dorsal valve*, under the large V-shaped cardinal process, there exists a longitudinal ridge, which extends to two thirds the length of the valve, being widest, rounded, and grooved near its origin under the cardinal process, but becoming narrower and more elevated towards its extremity. On either side of the cardinal process there exists depressions for the reception of the teeth of the opposite valve, while

on either side of the upper part of the central ridge are situated large, wide, ramified impressions, due to the adductor muscle, while outside and in front of these are the two so-termed reniform impressions,[1] and a little under the adductor scars above mentioned may be noticed a small, conical eminence (z), which will also be seen in the interior of the same valve of *P. giganteus.*

This is the first notice that has been given of the interior of the dorsal valve of this remarkable species, and which corresponds so exactly with what we find in similar valves of other *Producta* that no further comments upon its generic claims appear to be necessary. While in ignorance of the interior character of the dorsal valve, I had, along with other palæontologists, been led to place this shell in the sub-genus *Chonetes*, having attributed undue importance to the area and teeth, which had until then been considered peculiar to *Chonetes*, and not to *Productus;* but since the discovery of a well-defined area in *P. sinuatus*, as well as occasional hinge-areas in *P semireticulatus*, *P. punctatus*, &c., we cannot claim the area as a permanent distinguishing feature between *Productus* and *Chonetes.* Mr. D. C. Davies states in his paper already referred to that *P. Llangollensis* exists in great plenty in the lower beds of the Carboniferous series at the base of the cliffs near Llangollen, and that it is also found, though not so abundantly, at about the same level at Llanymynech and Porthywaen; that in the Eglwseg cliffs it lies in a shale bed, from which beautiful specimens of the interior of the ventral valve may be obtained. It is, however, important to notice that the generality of specimens are so imperfect round the margin as to lead one to imagine that they had been drifted from some distance to the spot where they are at present found.

CHONETES CONCENTRICUS, *De Kon.* Plate LV, fig. 13.

CHONETES CONCENTRICA, *De Koninck.* Monographie du genre Chonetes, p. 186, pl. xx, fig. 19, 1847.

Shell marginally semicircular, about twice as wide as long, flat in the casts; hinge-line straight, angle rounded. External surface covered with numerous sub-regular, concentric ridges (thirty-seven being present on a specimen one inch and a quarter in length). The largest specimen at present known measures $1\frac{1}{2}$ inch in length by 3 inches in width.

Obs. In the Carboniferous Limestone at Clatteringwell Quarry, Bishop's Hill, Kenness Wood, Kinross, in Scotland, were recently found a number of external and imperfect internal impressions of a shell which neither Mr. Salter nor myself were at the time able to determine. Upon showing the specimen here described, and belonging to the Geolo-

[1] Prof. Suess advocates the opinion that the reniform impressions are equivalent to the sunken oral processes of Thecidium (?).

gical Survey, to Prof. L. de Koninck, he at once appeared disposed to refer it to a large variety of *Chonetes concentrica;* but as none of the Belgian specimens from the Lower Carboniferous Limestone of Visé have attained more than about one third of the dimensions of our Scottish examples, and as the concentric ridges are so much more numerous in these last, I have adopted our friend's identification with some reserve, and especially so as our Scottish material is very imperfect, and hardly sufficient to justify a positive conclusion. *Sp. ovalis, Strep. crenistria, Prod. scabriculus,* &c., occur in the same locality.

Prof. de Koninck describes his *C. concentrica* as small, transversely semicircular; ventral valve very slightly convex, dorsal one very feebly concave, surface of each valve ornamented with from twelve to fifteen concentric ridges.

In the explanation of Pl. XLV, with figs. 1—6, write "*Productus Llangollensis*" instead of "*Chonetes comoides.*"

Before concluding this Appendix I must briefly allude to several casts and impressions of a *Chonetes* recently discovered by Mr. J. Kirkby, in a Lower *Permian* Limestone, at Hartley quarry, Sunderland, in Durham, and which will thus add another species to our list of British Permian Brachiopoda.

These casts exactly agree in shape and dimensions with Phillips's *Chonetes Hardrensis,* and to which species I should have at once referred them had I been able to satisfy myself that the external markings, striation, &c., were those of the Carboniferous shell.

These casts are smooth, and show no evidence of striation, and some examples, without considering dimensions, bear some resemblance to Schauroth's Permian *Chonetes Davidsoni.*[1]

All I can, therefore, at present say with regard to these interesting specimens is that the shell is marginally semicircular, wider than long, plano-convex; hinge-line straight, and either a little shorter or as long as the width of the shell; that each valve is provided with a sub-parallel area, but which is widest in the ventral one, and divided in the middle by a small fissure, partly arched over by a pseudo-deltidium. The ventral valve is mode-

[1] "Ein neuer Beitrag zur Paläontologie des deutschen Zechsteingebirges" ('Abdruck. a. d. Zeitschr. d. deutschen Geologischen Gesellschaft,' Jahrg, 1856, pl. xi, fig. 1).

Baron Schauroth's *C. Davidsoni* appears to be a small shell, not exceeding three lines in length by about four in breadth, is semicircular, but comparatively and proportionately longer than wide than is *C. Hardrensis;* concavo-convex, with six slanting spines on the cardinal edge. The surface is marked with numerous concentric lines of growth, which are crossed by some radiating striæ. It is now an undoubted fact that *Chonetes* has continued to exist since the Lower Silurian epoch up to the Permian one inclusive.

rately convex, the dorsal one gently concave, and about eight slanting spines rise from the cardinal edge. Surface markings unknown. Length 6, breadth 8 lines. In Pl. LV, fig. 16, will be found a correct representation of these casts, which Mr. Kirkby found to be associated with a large variety of *Sp. Urii*, and with some Permian species belonging to other classes. Mr. Kirkby assures me that the bed containing these fossils is truly Permian. The Rothleigende, Marlstone, and about fifty feet of the Lower Limestone, are all to be seen in the same quarry below it.

INDEX TO THE APPENDIX.

PLATE XLVIII.

CARBONIFEROUS SPECIES.

Fig.	
1, 2.	*Crania quadrata*, M'Coy. Fig. 1 from the original figure in the 'Synopsis;' fig. 2 from the original specimen in the collection of Sir R. Griffith, Rahans Bay, Dunkineely, Ireland.
3—12.	,, ,, Different Scottish examples, from the Carboniferous shales of Carluke, Capelrig, Calderside, &c. These figures show the exterior of the upper valve and the interior of the lower or attached one. Figs. 6, 11, and 12, show how irregular the shell sometimes becomes from being too closely clustered round some marine object.
13.	,, ,, Interior of the upper valve, from Capelrig, collection of Mr. J. Armstrong.
14.	*Crania ? trigonalis*, M'Coy. From the original specimen in the collection of Sir R. Griffith. 14a. Magnified view, from Lisnapaste, Ballintra.
15.	,, ? *Ryckholtiana*, De Kon. = *Crania vesiculosa*, M'Coy, from the figure in the 'Synopsis of the Carboniferous Fossils of Ireland.' Carboniferous limestone, Millecent, Ireland.
16.	,, ,, Another example, in the collection of Mr. Humphreys.
17.	,, ? ,, From Castleton, in Derbyshire.
18—25.	*Discina nitida*. Different specimens, chiefly from the Carboniferous shales of Capelrig, Auchentibber, and Carluke, in Scotland. Fig. 18 represents the var. *D. bulla*, M'Coy, from Gare, Lanarkshire. Fig. 20^b is a portion of the shell enlarged.
26.	,, *Davreuxiana*, De Koninck ? From the Carboniferous limestone of Little Island, near Cork, Ireland, collection of Mr. J. Wright.
27, 28.	*Lingula Scotica*, Dav. Fig. 28 from the Carboniferous shales of Hall Hill, near Lesmahago, and collection of Dr. Slimon. Fig. 29 from Gare, collection of Mr. J. Armstrong.
29, 30.	,, *mytiloides*, Sow. From the original figures in the 'Mineral Conchology.' Walsingham, Durham; British Museum.
31—33.	,, ,, From Craigenglen and Capelrig, Scotland.
34.	,, ,, = *L. elliptica*, Phillips. From the original figures in the 'Geol. of Yorkshire.'
35.	,, ,, = *L. parallela*, Phil. From the original figures in the 'Geol. of Yorkshire.'
36.	,, ,, = *L. marginata*, Phil. From the original figure in the 'Geol. of Yorkshire.'
37.	,, *latior*, M'Coy. From the original figure in the 'British Palæozoic Fossils.'
38—40.	,, *Credneri*. From drawings by Mr. Kirkby. Carboniferous shales of Rynope Winning, near Sunderland, collection of Mr. Kirkby.

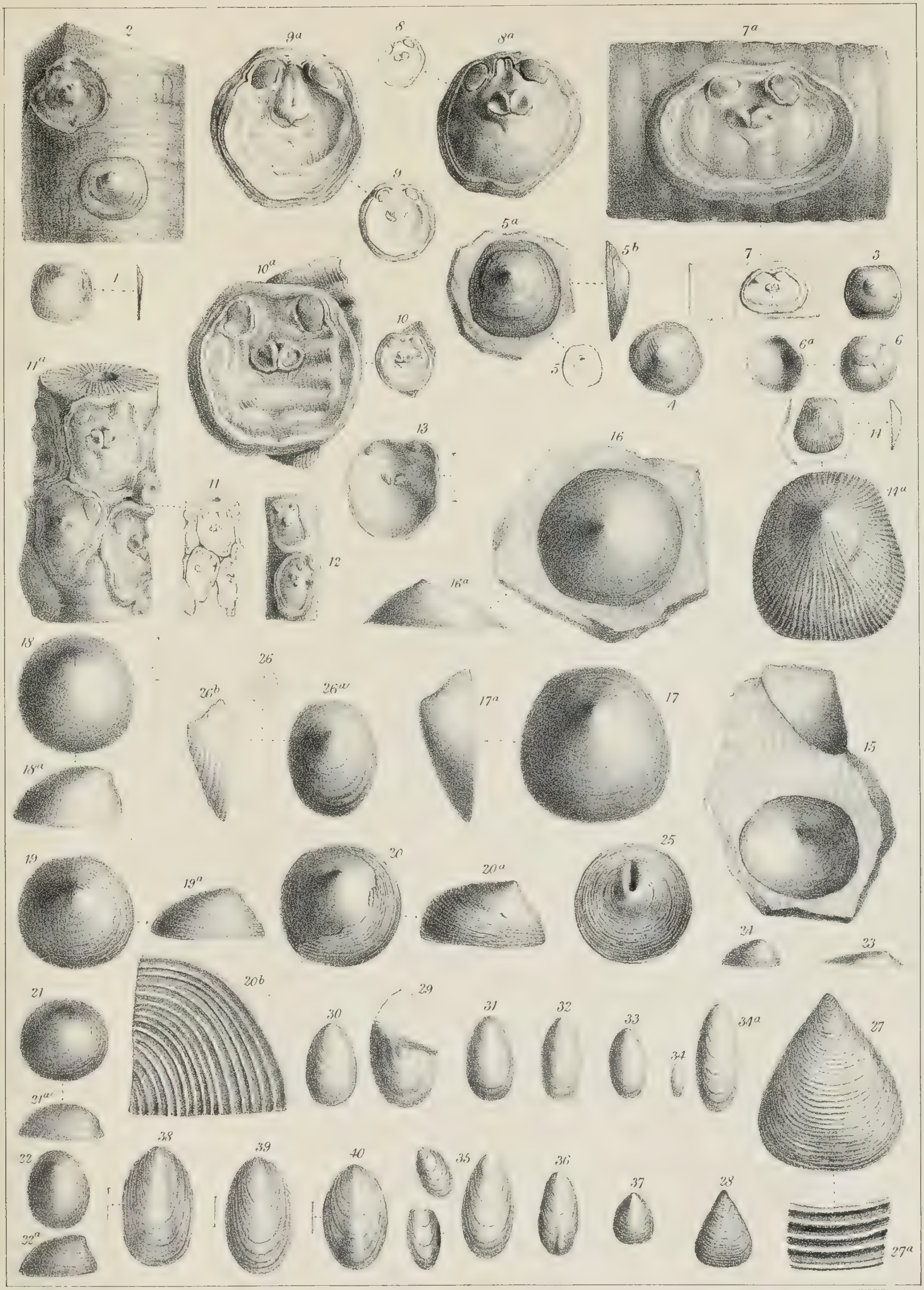
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PLATE XLIX.

CARBONIFEROUS SPECIES.

Fig.		
1.	*Lingula squamiformis*, Phillips.	The original specimen. Bolland; Gilbertsonian collection, British Museum.
2.	,, ,,	From Carboniferous shales, near Glasgow. Museum of Practical Geology.
3, 4, 5.	,, ,,	From near Carluke and Lesmahago, Lanarkshire.
6.	,, ,,	In Carboniferous shales. This fine bivalve specimen was found by Mr. Rodwell at about a mile to the east of Bally Castle, on the north coast of Antrim, in Ireland.
7.	,, ,,	A portion of the shell enlarged, to show its sculpture.
8.	,, ,,	Large, crushed, specimens, from an ironstone bed one mile north of Glasgow.
9.	,, ,,	M. Interior of the ventral valve. N. An internal cast of the dorsal one, from 341 fathoms below "Ell Coal," in the parish of Carluke, Lanarkshire.
10.	,, ,,	Interior of the ventral valve, from Lemmington, Northumberland, collection of Mr. Tate.

(Supplementary illustrations.)

11.	*Terebratula hastata.*	A very large, full-grown specimen. This shell is labelled "Bolland" in Dr. Bowerbank's collection.
12.	,, ,,	With colour-markings. Settle, Yorkshire.
13—16.	,, ,,	These figures are taken from specimens distorted by pressure or cleavage, to show what extraordinary modifications a same species may assume in fossilization under peculiar circumstances. From the Carboniferous limestone of Cork, in Ireland.
17.	,, ,,	Interior, showing the loop. Settle, Yorkshire.
18—20.	,, ,,	Var. *Gillingensis*, Dav.
21—26.	,, ,,	Passage forms connecting *T. hastata* with *T. vesicularis.* From the Carboniferous limestone of Bowertrapping, three miles south of Dalry, in Scotland. Fig. 26 in the collection of Mr. R. Galloway, of Paisley.
27—30.	,, ,,	Passage shapes between *T. sacculus* and *T. vesicularis.* From Settle and Gilling, in Yorkshire.

Thos Davidson del. et lith.

W West imp

PLATE L.

CARBONIFEROUS SPECIES.

(*Supplementary illustrations.*)

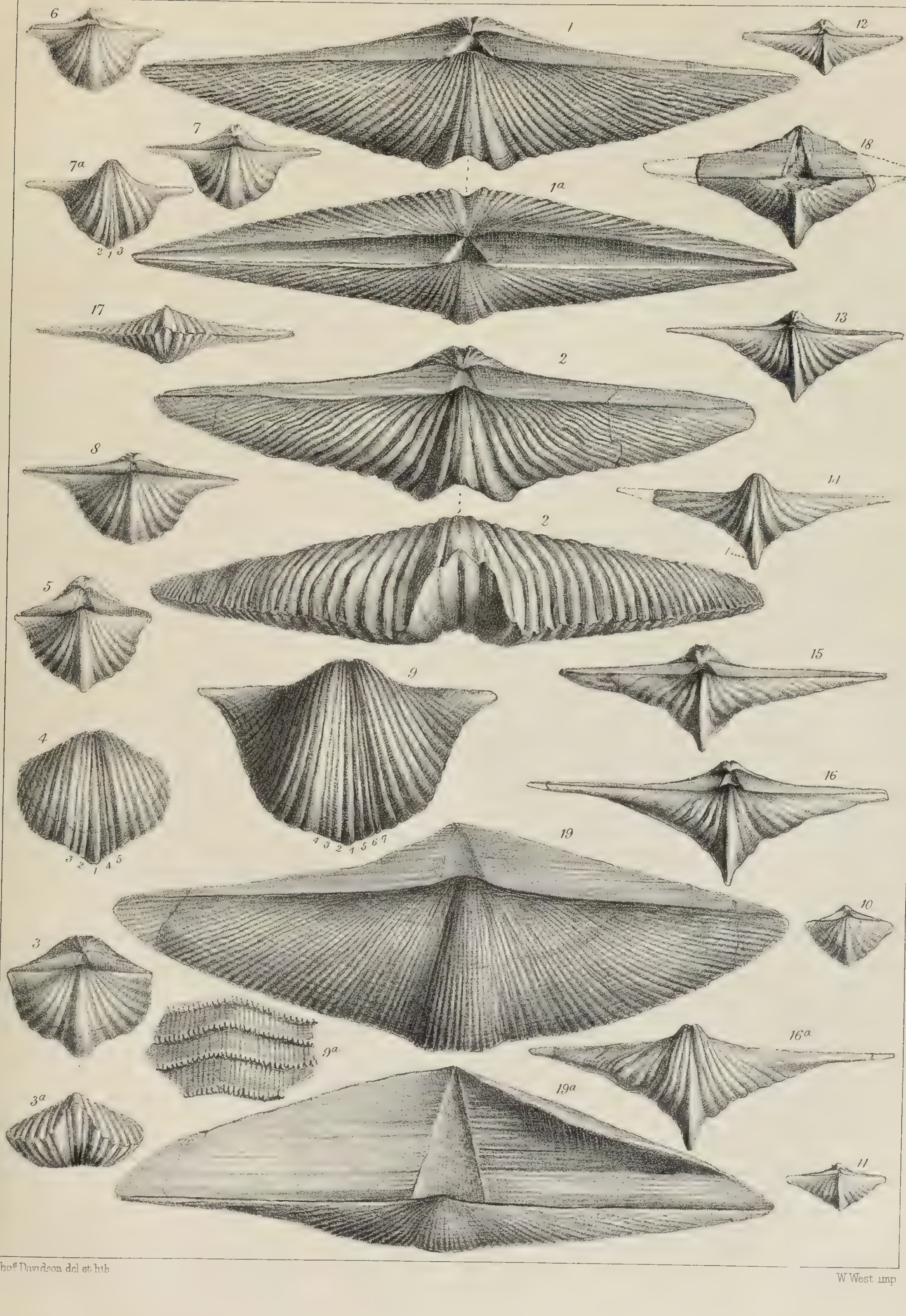
FIG.

1, 2. *Spirifera convoluta*, Phillips. Two very large and fine examples from the Carboniferous limestone of Thornely, near Chipping, Lancashire. Fig. 1 is perfect, and from the collection of Mr. J. Rofe, of Preston.

3—9. „ *trigonalis*. Various specimens to illustrate certain modifications or passage shapes connecting *Sp. trigonalis* and *Sp. bisulcata*. Fig. 3 from Brockley, near Lesmahago; fig. 4 from Cousland, near Dalkeith, Scotland; figs. 5, 6, 7, showing the gradual prolongation of the wings in certain individuals, from the Lower Scar limestone of Settle, in Yorkshire; fig. 8 from Derbyshire, in the collection of Dr. Fleming, of Manchester; fig. 9 from Barrhead, Renfrewshire, Scotland.

10—18. „ *triangularis*. A fine series of specimens obtained by Mr. Burrow from the Lower Scar limestone of Settle, in Yorkshire.

19. *Cyrtina septosa*. A large specimen. From the Lower Scar limestone of Settle, in Yorkshire, and collection of Mr. Burrow.



Thos Davidson del et lith W West imp

PLATE LI.

CARBONIFEROUS SPECIES.

(*Supplementary illustrations.*)

Fig.

1, 2. *Productus sub-lævis.* From the Carboniferous limestone of Clitheroe, in Lancashire. Fig. 1 in the collection of Mr. J. Parker, of Manchester.

3. *Retzia* or *Rhynchospira Carbonaria,* Dav. From the lower black Carboniferous shales of Skrinkle, Pembrokeshire, and Museum of Practical Geology.

4—9. *Retzia radialis,* Phillips. Various modifications in shape. From Yorkshire, Derbyshire, and Scotland.

10. „ ? Uncertain form. From Derbyshire.

11—13. *Athyris plano-sulcata,* Phillips. Specimens distorted by pressure and cleavage. From the Carboniferous limestone of Cork. Fig. 11 is the original specimen from which M'Coy's *A. virgoides* of the 'Synopsis' was created, now in the collection of Mr. J. Wright, of Cork. Fig. 13 shows portions of the fringe.

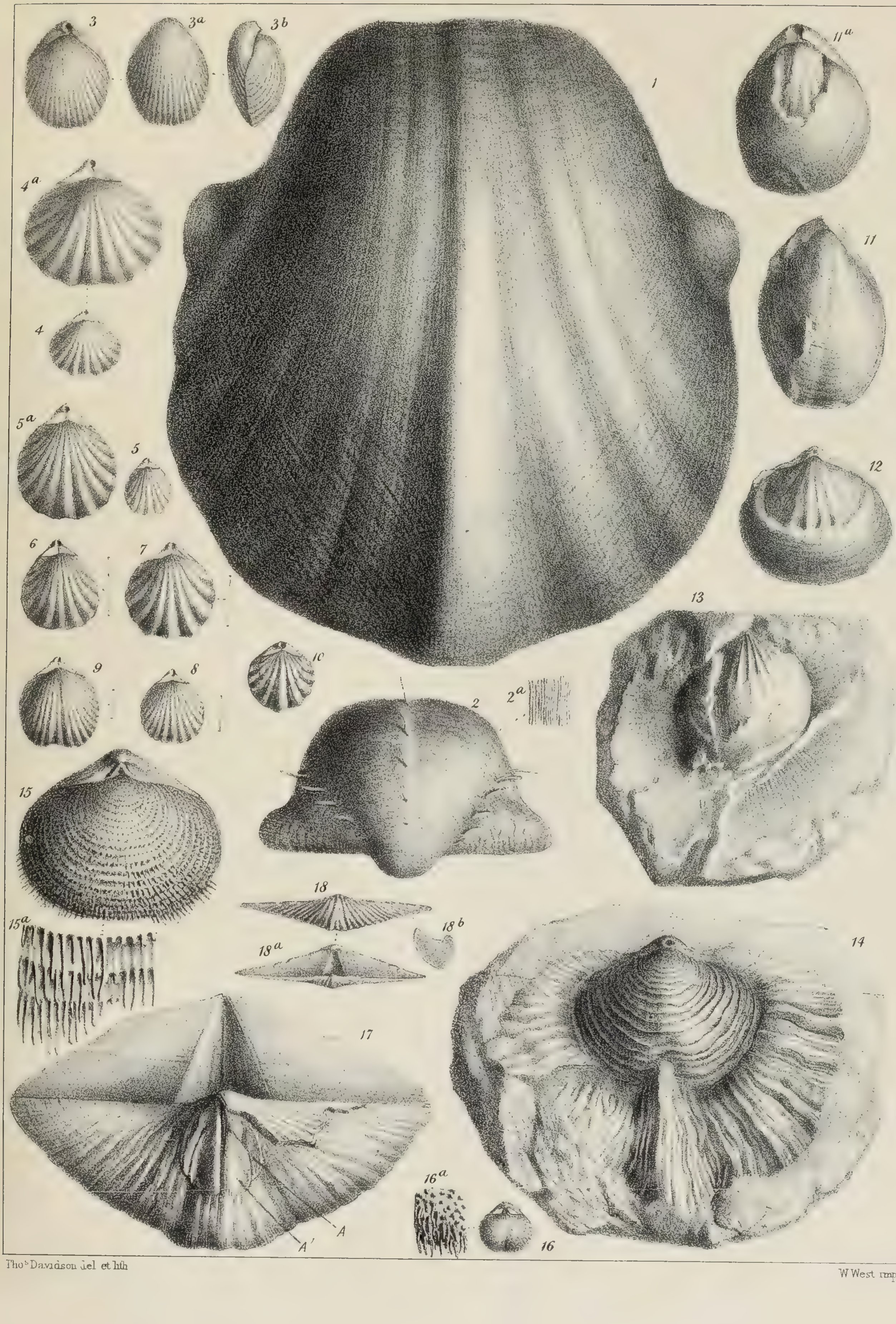
14. *Athyris lamellosa,* L'Eveilé. With portions of its fringe-like expansions. From the Carboniferous limestone of Little Island, Cork, Ireland.

15. *Spirifera lineata,* Martin. Showing the manner in which the rows of spines succeed each other over the surface of the valves. 15^{a} portion enlarged. From the Carboniferous shales of West Broadstone, near Beith, Ayrshire.

16. „ *Urii.* Natural size, showing its spiny investment. Fig. 16^{a} a portion enlarged. Hill Head, Lanarkshire.

17. *Cyrtina septosa,* Phillips. The shell being removed from the dorsal valve, shows upon the internal cast the impression of the posterior (A) and anterior (A′) adductor muscles. From Settle, Yorkshire.

18. „ „ A very transverse young specimen. From Wetton, in Staffordshire.



Thos Davidson del et lith

W West imp

PLATE LII.

CARBONIFEROUS SPECIES.

(*Supplementary illustrations.*)

FIG.

1. *Spirifera striata*, Martin. An elongated specimen from the Lower Scar limestone of Settle, in Yorkshire, collection of Mr. Burrow.

2. „ „ A very transverse example, *Sp. attenuata*, Sow. From Little Island, Cork, collection of Mr. J. Wright.

3. „ *cuspidata*, Martin. From the Lower Scar limestone of Settle, in Yorkshire.

4. „ *subconica*, Martin. A remarkable specimen, showing its beautiful laminated sculpture, from the Carboniferous limestone of Wetton, Staffordshire, collection of Mr. Carrington. 4[a] portion of the ornate surface enlarged.

5. „ *distans*, Sow. This specimen was labelled *Sp. bicarinata* by Professor M'Coy, and is from the Carboniferous limestone of Cork, in Ireland, collection of Mr. J. Wright.

6. „ *duplicicosta*, Phillips. With a prolonged mesial fold, and resembling the figure in Pl. V, fig. 35, of the present Monograph, there erroneously termed *Sp. trigonalis*. From the Carboniferous limestone of Derbyshire, collection of Dr. Fleming, of Manchester.

7. „ ? „ From the Carboniferous limestone of Allstonefield, near Wetton, in Staffordshire. This is a curious form, of which I have seen several specimens, and in which the apex of the beak of the ventral valve is at a lower level than the umbone of the dorsal valve; it is, perhaps, a malformation of *Sp. trigonalis* or *bisulcata*, as some of the specimens have much the appearance of that species.

8. „ *ovalis*, Phillips. Interior of the dorsal valve, to show the compressed shape assumed by the spirals. I have seen several examples so disposed in this as well as in *Sp. integricosta*. From the Carboniferous limestone of Wetton, in Staffordshire.

9, 10. *Spiriferina cristata*, var. *octoplicata*, Sow. From Brockley, near Lesmahago, Lanarkshire. Fig. 10 from Wetton, in Staffordshire.

11, 12. „ *octoplicata*, var. *biplicata*, Dav. From the Lower Scar limestone, Settle, in Yorkshire.

13. „ „ A specimen with three plaits on the mesial fold (very uncommon), figured by Sowerby in the 'Min. Conchology.'

14, 15. „ *insculpta*, Phillips. Two shapes from the Lower Scar limestone of Settle.

16, 17. „ *acuta*, Martin. Fig. 16 the original figure from a Derbyshire specimen. Fig. 17 from Settle.

18—20. *Athyris Carringtoniana*, Dav. Carboniferous limestone of Wetton, in Staffordshire.

21. *Chonetes Buchiana*, De Kon. A large specimen from the Lower Scar limestone of Settle. The specimens from the limestone have their ribs usually more numerous and smaller than those which occur in the shales of Malham Moor, near Settle.

22. *Camarophoria* ? ——— From the limestone of Wetton, in Staffordshire; it resembles much, but in large certain specimens of *Camarophoria crumena*. ?

Thos Davidson del et lith

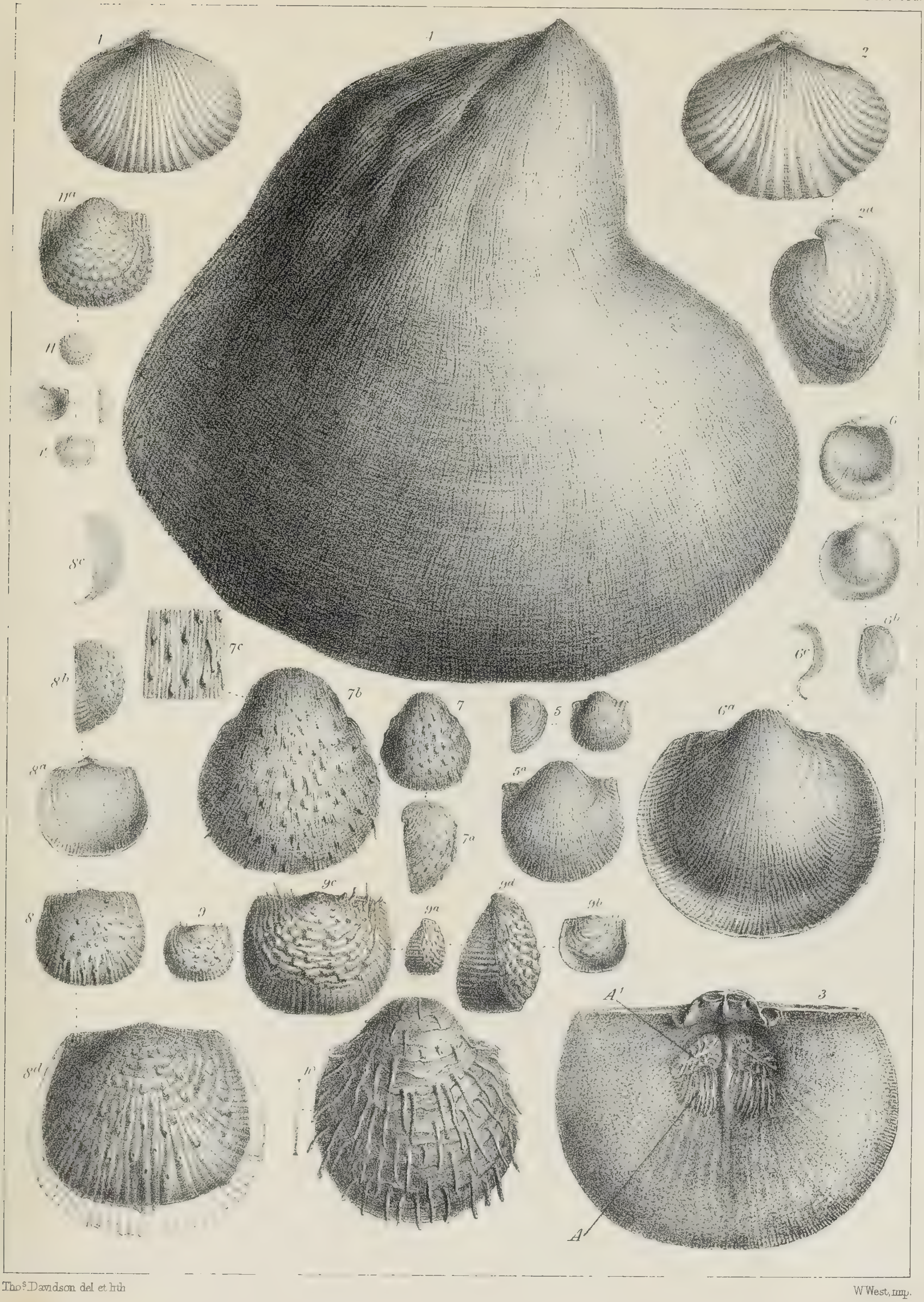
W West imp

PLATE LIII.

CARBONIFEROUS SPECIES.

(*Supplementary illustrations.*)

Fig.		
1, 2.	*Rhynchonella Carringtoniana*, Dav.	Carboniferous limestone; Wetton, Staffordshire.
3.	*Streptorhynchus crenistria*, Phillips.	Interior of the dorsal valve from Malham Moor, in Yorkshire, showing in a beautiful manner the muscular impressions: A′, posterior adductor or occlusor; A, anterior adductor or occlusor.
4.	*Productus striatus*, Fischer.	A very large example from Wetton, in Staffordshire, and collection of Mr. Carrington.
5, 6.	,, *undiferus*, De Koninck.	Lower Scar limestone of Settle, in Yorkshire. 5^a and 6^d enlarged.
7.	,, *Koninckianus*, De Verneuil.	Settle. $7^{b, c,}$ enlarged.
8.	,, *marginalis*, De Koninck.	Settle. $8^{d,}$ enlarged.
9.	,, *Nystianus*, De Koninck.	Settle. 9^c and $9^{d,}$ enlarged.
10.	,, *aculeatus*, Martin.	With its spines preserved. From the Carboniferous shales, near Settle. Enlarged.
11, 12.	,, *Deshayesianus*, De Koninck. ?	Fig. 12, Professor Koninck's original specimen. $11^{a,}$ enlarged. Settle, Yorkshire.



Thos. Davidson del et lith

W West, imp.

PLATE LIV.

CARBONIFEROUS AND PERMIAN RECURRENT SPECIES.

FIG.

1. TEREBRATULA HASTATA, *Sow.* Carboniferous limestone, Settle, Yorkshire.

2. „ elongata, *Schlotheim.* Permian limestone, Humbleton Hill, Durham. Collection of Mr. J. Kirkby.

3. „ hastata, *Sow.;* var. Gillingensis, *Dav.* Carboniferous limestone, Gilling, Yorkshire.

4. „ elongata, *Schlotheim.* Permian limestone, Tunstall Hill.

5. „ SACCULUS, *Martin.* Carboniferous limestone, Bolland, Yorkshire.

6. „ sufflata, *Schlotheim.* Permian limestone, Tunstall Hill, Durham.

8. ATHYRIS ROYSSII, *L'Eveillé.* Carboniferous shales, Brockley, near Lesmahago, Lanarkshire, Scotland.

9. „ pectinifera, *J. de C. Sow.* Permian limestone, Humbleton, Durham.

10 and 12. Spiriferina octoplicata, *Sow.* Carboniferous limestone and shale. Fig. 10, Sowerby's type ('Min. Con. Tab,' 562, fig. 2), Derbyshire. Fig. 12 from East Kilbride, Lanarkshire, Scotland.

11 and 13. „ CRISTATA, *Schlotheim.* Permian limestone of Tunstall Hill, collection of Mr. J. Kirkby.

14. SPIRIFERA URII, *Fleming.* Carboniferous shales near Carluke, Lanarkshire, Scotland.

15. „ Clannyana, *King.* Permian limestone, Tunstall Hill, Durham.

16, 17, 18. CAMAROPHORIA CRUMENA, *Martin,* sp. Carboniferous limestone of Derbyshire, and of Settle, in Yorkshire.

19. „ Sclotheimi, *Von Buch.* Permian limestone, Tunstall Hill.

20, 21, 22. „ rhomboidea, *Phillips.* Carboniferous limestone, Settle, Yorkshire.

23, 24, 25. „ GLOBULINA, *Phillips.* Permian limestone, Tunstall Hill.

26. DISCINA NITIDA, *Phillips.* Carboniferous shales, Capelrig, Lanarkshire, Scotland.

27. „ Koninckii, *Geinitz.* Permian compact limestone, East Thickley, Durham.

28, 29, 30, 31. LINGULA MYTILOIDES, *Sow.* Carboniferous limestone and shales. Figs. 28, 29, Sowerby's types, from Walsingham, Durham. Var. *L. Credneri,* Figs. 30, 31, from the Coal measures of Ryhope, Winning, near Sunderland, Durham, collection of Mr. J. Kirkby.

32, 33, 34. „ Credneri, *Geinitz.* Permian marl slate and lower beds of the compact limestone of Ferry Hill, and East Trickley, Durham.

35, 36, 37, 38. Crania Kirkbyi, *Dav.* Permian limestone, Tunstall Hill, collection of Mr. J. Kirkby.

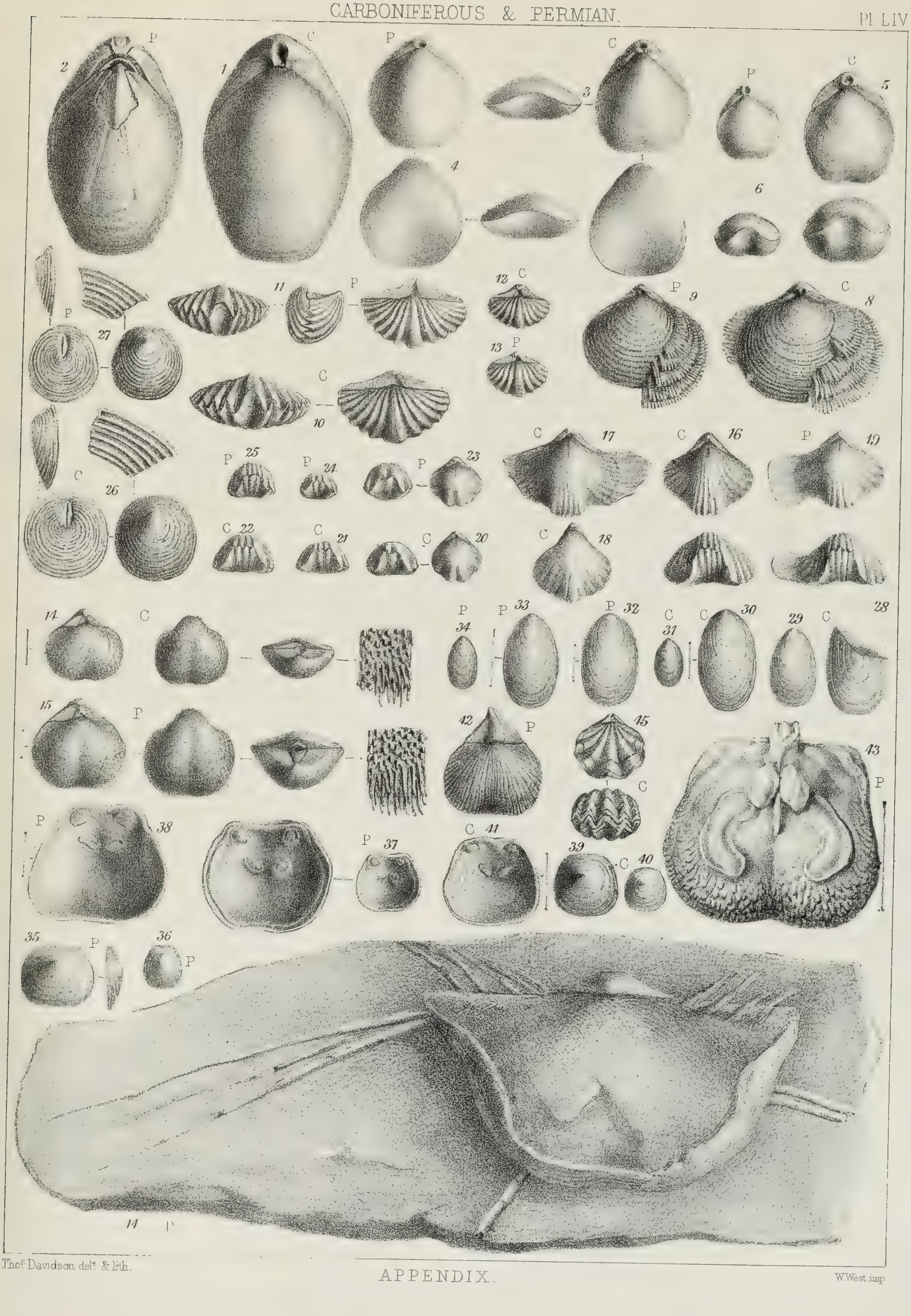
39, 40, 41. „ QUADRATA, *M'Coy.* Carboniferous shales of Capelrig, East Kilbride, Lanarkshire.

42. Streptorhynchus pelargonatus, *Schlotheim.* Permian compact limestone of East Trichley. A very large example.

43. Strophalosia Goldfusii, *Münster.* Interior of the dorsal valve. A strongly marked example from the Permian limestone of Tunstall Hill, collection of Mr. J. Kirkby.

44. Productus horridus, *Sow.* A specimen in the Permian compact limestone of East Thickley, showing very long spines. Collection of Mr. T. Parker, of Darlington.

45. Retzia ulstrix, *De Koninck.* A very fine and perfect example, discovered by Mr. S. Carrington in the Carboniferous limestone of Wetton, in Staffordshire.



Thos Davidson delt & lith.

APPENDIX.

W.West imp

PLATE LV.

CARBONIFEROUS SPECIES.

Fig.

1, 2, 3. *Rhynchonella Wettonensis,* Dav. Three specimens from Narrowdale, near Wetton, Staffordshire.

4. *Athyris* ? From the Carboniferous Limestone of Wetton. This specimen is here figured, but not named or described, on account of the material at hand not being sufficient to warrant the establishing of a new species. It may, perhaps, be an abnormal form of *Athyris plano-sulcata* ?

5. *Productus Carringtoniana,* Dav. Narrowdale, Staffordshire.

6, 7. „ *comoides,* Sow. The original examples ('Min. Con.,' tab. 329, lower figures) from the Wayboards, between the limestone under the coal, at Llangaveni, in Anglesea. British Museum.

8. „ „ „ ('Min. Con.,' tab. 329, the upper figures). From the same locality and collection. Since this specimen was drawn by Sowerby in his 'Mineral Conchology' I have removed the matrix, so as to expose the interior muscular impressions. The upper attachment of the adductor partially seen (A), of the lower ones (*c*) are clearly exposed. R. Cardinal or divaricator impressions. British Museum.

9, 10. „ *Llangollensis,* Dav. Interior of the dorsal and ventral valves, belonging to the same specimen recently found by Mr. D. C. Davies, of Oswestry, in the Carboniferous limestone of Llangollen, Denbighshire; 9 represents the ventral valve, and shows the small area, teeth, adductor (B and C), as well as the cardinal or divaricator impressions (R). Fig. 10 represents the dorsal valve, and shows the cardinal process, adductor impressions (A), reniform markings (X), and the eminences (Z). This is the only specimen hitherto discovered of the interior of the dorsal valve.

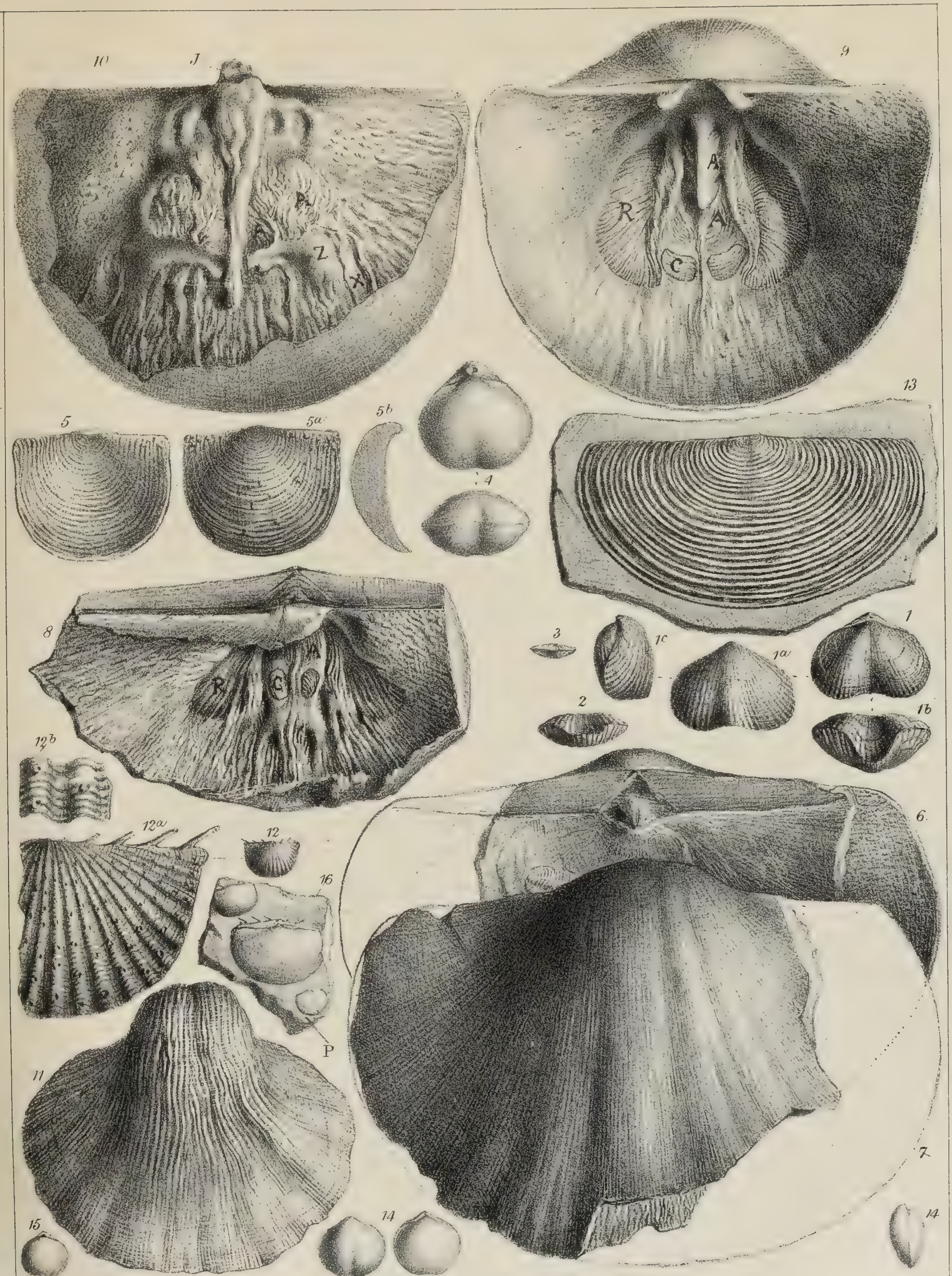
11. „ *Martini,* Sow. A very remarkable specimen, showing a peculiar shape and modification of striation near the margin. From the Carboniferous limestone of Wetton, Staffordshire.

12. *Chonetes Buchiana,* De Koninck. A small variety, recently found in great abundance by Mr. W. W. Stoddart in the Carboniferous limestone near Bristol. Some of the specimens are perfectly preserved, and show that the entire surface of the valves were ornamented with minute, contiguous, concentric striæ, and we may also observe along the surface of the ribs the basis of numerous spines.

13. „ *concentrica,* De Koninck? Impression of the exterior of one of the valves, from the Carboniferous limestone of Clatteringwell quarry, Bishop's Hill, Kenness Wood, Kinross, Scotland. Museum of Practical Geology.

14, 15. *Spirifera Carlukiensis,* Dav. A large variety, recently discovered by Mr. S. Carrington in the Carboniferous limestone of Narrowdale, near Wetton, in Staffordshire, in which locality it occurs by myriads.

16. *Chonetes* ? From a bed of lower Permian limestone at Hartley quarry, Sunderland, Durham, recently discovered by Mr. Kirkby. It is impossible, from the state in which the shell is found, to decide whether it belongs to *C. Davidsoni,* Schauroth, or to *C. Hardrensis.*



Thos Davidson del. & lith. W West imp

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

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MONOGRAPHS

ON THE

BRITISH FOSSIL

R E P T I L I A

FROM

THE OOLITIC FORMATIONS.

BY

RICHARD OWEN, F.R.S., D.C.L.,

FOREIGN ASSOCIATE OF THE INSTITUTE OF FRANCE, ETC., ETC.

PART SECOND,

CONTAINING

SCELIDOSAURUS HARRISONII AND PLIOSAURUS GRANDIS.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1862.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

A MONOGRAPH

OF A

FOSSIL DINOSAUR

(*SCELIDOSAURUS HARRISONII*, Owen)

OF THE

LOWER LIAS.

PART II.

The continued attention paid by James Harrison, Esq., to the organic remains discovered during the quarrying operations on the face of the cliff of Lower Lias at Charmouth, Dorsetshire, with liberal encouragement to the workmen, has procured for the original discoverer of the first indication of the Scelidosaur the materials for the present account of an almost complete skeleton of that extinct reptile.

Following in the track opened out by the discovery of the skull described in the preceding Monograph,* about twelve successive blocks of Lias were secured, with more or less evident indications of included bones, all of which, together with the skull, have been purchased for the British Museum. Subsequent complete exposure of the included organic remains has brought to light the entire vertebral column of the trunk and tail, to very near the termination of the latter; the scapulo-coracoid arch and part of one fore limb being associated with the thorax, and the iliac bones and both hind limbs with the sacrum.

In the operation of clearing off the matrix, scattered dermal bones first presented themselves, and these were removed, with a note of their position, when it became plain that they did not touch or rest upon any part of the endo-skeleton. This being reached, the dermal bones in contact with it were left, save where they con-

* Volume of the Palæontographical Society for 1859, p. 7, Plates IV, V, and VI.

cealed some joint, process, or other light-giving or characteristic part of the framework. In the course of our operations it soon became evident that the whole vertebral column, in a series of consecutive and but slightly disturbed and mostly coarticulated segments, from the axis to the thirty-fourth caudal vertebræ inclusive, had been raised from their place of deposit; all the parts, save the centrum and a small and low coalesced neural arch, having ceased to be developed, in the terminal caudal vertebræ, the last of which in the recovered series was reduced to dimensions so small as to indicate that but very few remained to complete the tail of the Scelidosaur. The first vertebra of the neck was adherent to the back part of the skull described in the monograph of the Society's Volume for 1859, issued in 1861.

Vertebral Column. Tabs. I—IX.

In the series of Liassic masses following that which included the skull the first four contain twenty vertebræ, extending from the axis to the mass including the sacrum, and clearly consecutive save at one part of the neck.

The back part of the Liassic mass containing the skull of the Scelidosaur includes the atlas vertebra in connection with the occiput, and surmounted by a pair of dermal bones (Tab. I, fig. 1). The block which fits to the fractured surface including the body and the neurapophyses of the atlas contains the axis and third cervical vertebra (ib., fig. 2). The next piece contained one nearly entire cervical vertebra (ib., figs. 3 and 4) and part of a second vertebra. The third, larger, piece contains ten coarticulated vertebræ (Tabs. II and III), but the continuity of the fore part of this mass with the last mentioned cannot be clearly made out. The fourth block fits to that containing the ten dorsals, and includes the five consecutive vertebræ with part of a sixth (Tab. IV). The block which contains the sacrum, has also two vertebræ in advance of it (Tab. VI), part of the first of which lies in the preceding block.

Thus, we have evidence of at least twenty-two "true" vertebræ; but there may have been one or two vertebræ from the region of the neck which have not been recovered. The vertebra attached to the first sacral seems not to have supported ribs; the one in front of it has a pair of long, freely articulated ribs, and may be reckoned the last dorsal. Including this, there may be assigned sixteen vertebræ to the dorsal series, if we include therein the ten vertebræ in Tab. II, leaving six or seven to the cervical series. The lumbar series is thus reduced to one vertebra. The sacrum includes four vertebræ. Of the caudal series thirty-five vertebræ are preserved, in five consecutively fitting blocks of matrix, leaving parts of two terminal ones, so small and simple as to show that very few are wanting in the present fossil skeleton.

The modifications of the spinal column of the trunk and tail of the Scelidosaur can thus be studied and compared in sixty consecutive vertebræ of one and the same individual.

Cervical Vertebræ. Tab. I.

The fracture of the matrix including the skull has passed through the centrum (Tab. I, fig. 1, *c*), hypapophysis (ib., *hy*), and neurapophyses (ib. *n*, *n*), of the atlas.

The centrum of the atlas is small, and has been anchylosed with that of the axis (Tab. I, fig. 2, *x*). The vertical section of it is subquadrate, longitudinally grooved on each side; broader above than below. The hypapophysis (fig. 1, *hy*) is broader, but less deep, than the centrum, and the bases of the neurapophyses (ib., *n*, *n*,) extend down the sides of the centrum to articulate with the hypapophysis.

The neurapophyses (ib., *n*, *n*) are ununited above, as they are below, and have yielded to the oblique pressure; but the slight dislocation seems to have taken place without fracture of an upper union. There is no trace of spinous process; but above the neural arch of the atlas is a pair of large, thick, transversely oblong, dermal bones or scutes; the fractured surface of the most entire one, to the right (ib., *r*) is 2 inches in length by 1 in depth; it exposes a compact peripheral texture of 4 or 5 lines in thickness at the upper and outer part, and about 1 line at the under or inner part, with a fine cancellous structure between. To the broad hypapophysis of the atlas was articulated a long and slender rib (*pleurapophysis*) (ib., fig. 2, *pl*, *a*).

In the foregoing constitution of the vertebral segment succeeding the skull we have the reptilian condition of the atlas, with modifications most closely repeated by the *Crocodilia* amongst the existing members of the class. The *Crocodilia* alone show the transverse extension of the hypapophysis or "pseudo-centrum" of the segment, associated with the presence of articulations for the pleurapophysial elements. In lizards free pleurapophyses are not developed from the atlas or from the axis, rarely from the third cervical vertebra. But in *Scelidosaurus* the atlantal hypapophysis is relatively broader than in *Crocodilia*, and there is no trace of the detached representative of the neural spine which characterises the atlas in Crocodilia.* In Plesiosaurus and Ichthyosaurus the true centrum of the atlas progressively acquires its form and proportions as such, and in the same degree resembles, in its relations to the basi-occipital, and to its own neural arch, the centrum of the first trunk-vertebra in fishes. The hypapophysis is proportionally reduced in size, and forms the first of the "sub-vertebral wedge-bones" in the *Ichthyosaurus*.*

The second block of Lias (Tab. I, fig. 2) includes the bodies of the axis (*x*)

* See descriptions and figures of the modifications of the atlas and axis in my paper on the homologies of those bones in the 'Annals and Magazine of Natural History,' vol. xx, pp. 217—225.

and of the third cervical vertebra (*a*, 3) with parts of the pleurapophyses of the atlas (*pl. a*) and axis (*pl. x*); it includes, also, large, massive dermal bones external and superior to the vertebral elements. The centrum of the axis is 1 inch 3 lines in length, from the line of adhesion of that of the atlas, part of which remains connected, as the "odontoid process;" the proper body of the axis is subcarinate below; gently concave lengthwise at the sides; compressed in the same degree at the middle, and slightly expanded at the extremities. The rib which it supported (*pl' x*) is shorter than that of the atlas, but, like it, is slender and straight; about 3 inches of the atlantal rib is preserved, and about 2 inches of that of the axis.

The body of the third vertebra (3) presents a general increase of size; it is 1 inch 8 lines in length, 2 inches 3 lines across the parapophyses at the fore part of the vertebra, 1 inch 6 lines across the posterior articular surface, and 1 inch 2 lines in depth. It is subcompressed at the sides, and more obtusely ridged below than the axis. The fore part of the body is articulated by an almost flattened surface with that at the back of the axis.

The characters of the terminal articular surfaces are worked out more completely in a consecutive cervical vertebra detached from the third block, and which, from its size, is probably the sixth. The part of the front surface (fig. 4, 6) which is preserved, is flat with a convex periphery; the hind surface (fig. 3, *c*) is slightly concave, with a narrower and better defined circumference. The body of this vertebra is 1 inch 10 lines in length, 2 inches 3 lines across the parapophyses (*p*); 1 inch 8 lines across the hinder articular end (*c*). The under part of the centrum presents near its fore end a hypapophysial tuberosity; it is constricted at the middle, and a small venous canal opens into that concavity on either side. The rib (*pl*) articulates by a bifurcate end with both par- and di- apophyses: the upper transverse process (fig. 4, *d*) extends nearly $1\frac{1}{2}$ inch from the neural arch; the neural canal (*n*) is of a full oval form, with the small end downwards; it is 9 inches in its longest diameter. The breadth of the neural arch, below the diapophyses, is 1 inch 7 lines.

In the portion of the succeeding cervical vertebra, from the same block, the rib is directed more outwardly than in the antecedent one. The length of the neck of the rib is 1 inch 2 lines; its thickness 6 lines, which increases after the development of the tubercle, where the fracture shows a subtriedral section. The portion of the articular surface which is preserved (*b*) of the centrum of the seventh vertebra indicates the same feeble concavity as in the preceding cervical vertebra (fig. 3).

Supposing the vertebra (Tab. 1, figs. 3 and 4) to be the sixth of the cervical series, it shows that the rib has more speedily resumed its normal character than in the *Crocodilia*. In these large existing Saurians the pleurapophysis, slender, straight and rather long, in the atlas and axis, becomes shortened and expanded in the third, fourth, fifth, and sixth cervical vertebræ, assuming in them a hatchet-like shape, with an overlapping arrangement; the posterior production of the "blade"

lengthens in the seventh cervical; but the ordinary rib-shape is only resumed in the eighth vertebra, regarded as the first dorsal by Cuvier.

I infer, therefore, from the size and proportions of the two vertebræ just described that they correspond with the sixth and seventh in the Crocodile, and that the Scelidosaurus, with probably other *Dinosauria*, differed from *Crocodilia* and from most *Lacertilia* in the long and slender form of most, if not all, of the cervical ribs; but that these manifested their more essential Crocodilian affinity in their twofold articulation, by a bifurcate head, with distinct upper and lower transverse processes.

The fourth block of Lias includes, with the scapular arch, ten of the anterior dorsal vertebræ (Tabs. II and III). The hinder fracture of the block has detached the anterior articular surface from the eleventh dorsal, the rest of which is the first of the series of the five following dorsals in the fifth block of Lias (Tabs. IV, figs. 1 and 2). The hinder fracture of this block has pretty equally bisected the last vertebra, which bears free ribs, viz., the sixteenth dorsal, the hinder half of which remains in the fore part of the block (Tab. VI), including the lumbar and sacral series of vertebræ. The section of the eleventh dorsal thus exposed near the anterior articular surface of the centrum is represented of the natural size in Tab. V, fig. 1, D 11. That through the middle of the sixteenth dorsal vertebra is similarly represented in Tab. V, fig. 2, D 16.

The spinous process of the first dorsal vertebra (Tab. II, D 1) is $1\frac{1}{2}$ inch in height and 8 lines in fore-and-aft extent; the spine increases in both directions to the fifth of these vertebræ (5), which is 2 inches 4 lines in height and 1 inch 10 lines in basal extent. The spines continue of about the same height to the tenth vertebra, D 10, with summits obtusely rounded, almost truncate. In the eleventh to the sixteenth dorsals, Tab. IV, D 11—D 16, the spines acquire their greatest fore-and-aft extent, with truncate summits, but no increase of height. Although these spines in the last six vertebræ are nearly $2\frac{1}{2}$ inches in antero-posterior extent, their summits do not come into contact, but leave interspaces of from 5 lines to 8 lines.

The prezygapophyses in the anterior dorsal vertebræ look inward and a little upward, the postzygapophyses in the reverse directions, but as the vertebræ recede in position the aspect of the surfaces becomes more nearly horizontal (Tab. V, fig. 1, *z*). The diapophyses are subdepressed, 10 lines in breadth in the second vertebra, and gradually increasing to a terminal breadth of 15 lines in the ninth and tenth dorsals Tab. II, *d, d*. The parapophyses, as in the Crocodile, gradually pass from the centrum to the neural arch, and are seen at *p*, fig. 1, Tab. V, upon the under and fore part of the diapophysis (*d*) in the eleventh of this series of dorsals, where the length of the diapophysis from the base of the neural spine is 2 inches 9 lines. No trace of parapophysis, or of the "head" of the rib, remains in the last three dorsals; the diapophysis is entire, as at *d*, fig. 2, Tab. V.

The ribs of the twelve anterior dorsal vertebræ show both the head and the tubercle, the neck becoming gradually shorter in the last three. In the seventh vertebra the extent of the rib from the head to the tubercle is 2 inches 9 lines. In the tenth vertebra it is 1 inch 7 lines. The rib presents a shallow canal along its posterior surface; it is nearly an inch in thickness. An extent of upwards of 10 inches of the body of the rib (*pl.*, Tab. II) is preserved on the right side of this portion of the thorax of *Scelidotherium.*

The anterior dorsal vertebræ have been partially dislocated, especially the fourth from the fifth, apparently by pressure acting through the scapula (51) upon the diapophysis and spine of the fifth dorsal. Beyond the scapula the vertebræ have retained their natural position and connections, which seems to indicate the action of pressure whilst decomposition of the soft parts was going on in the carcass. Nine of the consecutive vertebræ in the fourth block occupy the extent of 1 foot 9 inches. The breadth of the last of these vertebræ (Tab. II, D 10), across the diapophyses (*d*), is 5 inches 4 lines. The total height of the eleventh dorsal vertebra (Tab. 5, fig. 1) is 6 inches. The breadth of the centrum at the fractured part, near the anterior surface, is 1 inch 6 lines. The depth of the centrum, from the floor of the neural canal, is 2 inches. The breadth of the neural arch across what are called the "pedicles," is 1 inch 8 lines. The height of the neural spine is 2 inches 6 lines.

As the vertebræ approach the sacrum the bodies gradually increase in depth, without gaining in breadth, until at the last dorsal the centrum, near its middle part, measures $2\frac{1}{2}$ inches in vertical and 1 inch 7 lines in transverse diameter; a slight longitudinal impression on each side produces the contour of the transverse vertical section figured in Tab. V, fig. 2. The neural canal here gives a triangular section, with the apex downward and sinking into the substance of the centrum, but the sutural limit between centrum and neural arch are indiscernible. The diapophyses decrease in breadth and also in length, and now support the rib by a terminal, slightly notched, articular facet. The ribs, here with simple heads, become shorter and less curved; a few, as in Tab. IV, fig. 1, *pl*, have suffered fracture, with very little displacement. In different parts of the matrix of the blocks (Tabs. II and IV) are portions of long and slender bones, which are, most probably, abdominal ribs.

In the sixth block the hinder half of the last dorsal and one lumbar vertebræ are associated with the pelvis; the lumbar vertebra (Tab. VI, L) had been dislocated downwards from its articulations with the sacrum.

The four vertebræ of this part (Tab. VI), with the iliac bones (62), are preserved almost in their natural relative positions, the sacral vertebræ having their neural spines and transverse processes exposed. Those of the first sacral (S1, *d*, *pl*) stand out horizontally and transverse to the axis of the body; a slight swelling (*d*), about one inch from their origin, may indicate the point of confluence of the pleurapo-

physial (*pl*) with the par- and di- apophysial elements of this part. It is $4\frac{1}{2}$ inches in length; at its base it is 1 inch in thickness and 2 inches in depth, expanding in that direction to fully 3 inches at the truncate extremity, and in breadth to 2 inches 2 lines. Towards its end the process is excavated anteriorly, so that the rough terminal surface (fig. 2, *pl.*) abutting upon the iliac bone is reniform. Fracture of an angle of this surface in the left transverse process shows a medullary cavity of 10 lines in diameter by 6 lines in the section as exposed, surrounded by a fine cancellous, almost compact, osseous texture, of from 2 lines to 4 lines in thickness.

The transverse processes of the other sacral vertebræ gradually become shorter, with corresponding decrease of breadth at their origin, but with equal or greater expansion of their termination, that of the last (*pl, s* 4) measuring 2 inches 7 lines in fore and aft breadth; the transverse processes thus touch each other, or nearly so, at their ends, and offer a continuous longitudinal surface for the ligamentous or fibro-cartilaginous attachments of the iliac bones (62). The total length of the articular "sacro-iliac" tract, so formed, is about 10 inches; a very slight lateral twist or dislocation makes it rather longer on the left than on the right side; this appears to have been due to great pressure after imbedding, and is accompanied by fracture or dislocation of the pleurapophysial part of the transverse process of the last two sacral vertebræ.

The spinous process, in each of the four sacrals, is about 2 inches high and 2 inches 3 lines in fore and aft extent: they touch each other by their rough, flattened summits; these are narrow anteriorly, gradually expanding to a breadth of 8 lines at their posterior third, with a thick, rounded termination; the position of these spines is over the interspaces of the origins of the transverse processes, through the backward inclination or extension of the neural arches. The articular processes are faintly indicated at their base, the posterior processes overlapping the anterior ones of the succeeding vertebra. The longitudinal extent of the truncated summits of the four sacral spines is 9 inches.

The hinder fractured surface of the block containing the sacrum exposes part of the first caudal vertebra, the rest being associated with the four consecutive caudals in the seventh block of Lias (Tab. VII, figs. 1 and 2).

The first caudal vertebra has been dislocated from the last sacral, and twisted half round, so that its spine lies upon the sacral transverse process; the fracture has passed through the spine and part of the neural arch. The length of this spine (Tab. VII, fig. 1, *ns*) from the upper part of the neural canal is 3 inches 6 lines, the transverse process (*d*) is 2 inches 3 lines in length, but its vertical thickness is reduced to 5 lines at 2 inches from its termination. The neural canal is 6 lines in breadth and 10 lines in depth. The bases of the neural arch seem to show that the anchylosis with the centrum had not here been complete.

The length of the first caudal centrum (Tab. VII, *c* 1) is 2 inches, the depth or

vertical diameter of its articular end is 2 inches 5 lines; the surface is moderately concave, with the circumference bevelled off convexly; between the two expanded ends the centrum is moderately and uniformly concave lengthwise. There is no trace of hæmal arch in the first caudal. In the second that arch (Tab. VII, fig. 2, *h*) is articulated to the posterior part of the under surface, and is produced into a spine of nearly 4 inches long. In the third caudal (ib., *h*, *c* 3) and succeeding ones the hæmal arch has been dislocated, showing its articular surface, which, by mutual union of the hæmapophysial bases, is single, sub-reniform, transversely extended, lightly concave across, and convex from above downward. The hæmal canal, thus circumscribed, and well shown in the fourth caudal vertebra, is about 2 lines in breadth and 1 inch 3 lines in length; too narrow, it would seem, for the protection of the trunks of the blood-vessels supplying so long and so powerful an organ as the tail of the *Scelidosaurus*. This form of the hæmal canal or slit has every appearance of being natural, and not due to any posthumous compression. The hæmapophysial surface external to it is convex transversely, slightly concave lengthwise; the laminæ slightly contract to their union in the spine, which becomes compressed, and a little expanded from before backwards near its termination. The articular surface, after the second hæmal arch, is afforded in equal proportions by the two conjoined centrums beneath their terminal junction. The transverse process of the second caudal (ib., *d*) arises from the anterior two thirds of the vertebra, over the junction of the centrum with the neural arch; a trace of the suture indicating the pleurapophysial character of this process is discernible in this and some following caudals. The length of the centrum is 2 inches 2 lines; the fore and aft breadth of the base of the transverse process is 1 inch 5 lines; its length is 2 inches 5 lines; its terminal breadth is 10 lines, ending obtusely. The transverse processes progressively decrease in all these dimensions in the following vertebræ. The anterior zygapophyses (Tab. VII, fig. 1, *z*) are twice the length of the posterior ones (*z′*), by which their extremities are overlapped. The fore and aft breadth of the neurapophyses between these processes is 1 inch 2 lines; that of the summit of the neural spine is 1 inch 6 lines; the height of the spine from the base of the prezygapophysis is 3 inches 4 lines. These dimensions are taken from the third caudal vertebra. The five consecutive and coarticulated anterior caudal vertebræ in the present block of Lias give a collective longitudinal extent of 12 inches. The distal half of the right femur (Tab. VII, fig. 2, 65), and parts of the right tibia (ib., 66) and fibula (ib., 67), are cemented to the vertebræ by the matrix. Figure 1 in this plate gives a side view, fig. 2 an oblique under view, of the first five caudal vertebræ.

The succeeding (eighth) block includes the five vertebræ (Tab. VIII, fig. 1) next in succession. In these the length of the centrum continues to be a little over 2 inches, but they gradually decrease in other diameters, and especially in the

size of their diverging parts. The neural spine, in the ninth, is reduced to 2 inches 5 lines in length; the transverse process (ib., fig. 1, *d*) to 1 inch 3 lines. The hæmal arch and spine retain a length of 3 inches 3 lines. That of the seventh vertebra (fig. 1, *h*) has a basal diameter of 1 inch 1 line, decreasing to 6 lines at the end of the neural canal, and thence to a terminal diameter of 2½ lines, the fore-and-aft diameter being here 10 lines. The centrums progressively become more concave and compressed between the articular ends. The prezygapophyses (ib., fig. 2, *z*) have their articular surface turned more inward, and grasp, as it were, the shortening rudiments of the post-zygapophyses, the neural arch progressively contracting in breadth. The collective length of the five vertebræ in this block is 11 inches.

The ninth block of Lias contains the five succeeding caudals (Tab. VIII, fig. 3). The centrums, exposed at their under and lateral parts, are singularly crushed, the sides of each having been pressed into the substance; yet, where the cracks of the matrix expose the texture of the centrum, as in the fifteenth caudal (Tab. V, fig. 3), it shows a fine, compactly cancellous structure throughout; there is no trace of any such vacuity or unossified nucleus of the centrum as is met with in the vertebræ of *Poikilopleuron*, for example. The centrums retain their length of 2 inches. The hinder articular end of that of the tenth caudal (*c*) adheres to the fore part of the present block. In the next coarticulated vertebra, which is the eleventh of the caudal series (Tab. VIII, fig. 3, 11), the prezygapophysis (ib., fig. 4, *z*) is 10 lines in length and 3 lines in breadth; the neural spine, measured from the base of the zygapophysis, is 2 inches in length; the transverse process (fig. 3, *d*) is 1 inch in length, with half an inch of basal breadth. Nearly 2½ inches of the hæmal arch (ib., *h*) are preserved.

The pressure crushing the centrum of the eleventh vertebra has been applied to the middle of the under and lateral part; the articular ends have withstood, if they have received, it. The same is the case with the twelfth caudal. In the thirteenth the pressure has been more laterally applied, and the outer wall, which has been driven in, preserves its vertical convexity. The diapophysis of this vertebra is 10 lines in length. In the fifteenth caudal (ib., 15, *d*) the diapophysis is reduced to 6 lines in length, with corresponding decrease of thickness. The five caudal vertebræ from the eleventh to the fifteenth inclusive occupy a longitudinal extent of 11 inches 6 lines.

The tenth mass of Lias, fitting on to the foregoing, includes a consecutive series of nine vertebræ, viz., the sixteenth to the twenty-fourth caudal inclusive (Tab. IX, fig. 1). In this series there has been a dislocation of the eighteenth from the nineteenth, and a similar one between the twenty-first and the twenty-second vertebræ, with an interval of nearly an inch between the separated articular ends of the centrums. These elements continue to decrease in vertical and transverse diameters, and also, but in a minor degree, in regard to their length.

The transverse process has subsided to a tubercle upon the eighteenth (ib., fig. 1, *d*), and the postzygapophysis to a notch at the back part of the base of the neural spine, but the prezygapophysis (*z*) continues long and slender throughout this series. The neural spines progressively narrow and shorten, with a backward inclination. The base of the hæmal spine (*h*) of the sixteenth caudal measures 9 lines; its articular surface is transversely oblong. The surface for the articulation of the hæmal arch, from this part of the tail onward, is chiefly afforded by the hinder and under part of its own vertebra, as in fig. 3, *h*. The hæmal arch and spine becomes reduced in the eighteenth caudal to the length of its centrum; and in the twenty-third becomes shorter than the centrum, with a greater degree of antero-posterior expansion of the spine in proportion to the length of that part (ib., fig. 1, 23, *h*). The transverse diameter of the anterior articular surface of the nineteenth caudal is 1 inch 6 lines. The middle of the centrum has been reduced by pressure, attended with some fracture of the outer surface, to a diameter of 7 lines. In some of these vertebræ the middle, crushed parts of the centrum have been severed from the terminal articular expansions. I conclude, therefore, that they have been subjected to a general compressive force, probably connected with the change in the vertical relative position of the stratum. The compact layer of osseous tissue forming the articular end has resisted the pressure; the intervening, intermediate, cancellous structure has yielded to it.

From three smaller portions of the matrix, succeeding the ninth block, eleven consecutive caudal vertebræ were wrought out, as in Tab. IX, fig. 2, making us acquainted with a total of thirty-five caudal vertebræ of *Scelidosaurus*. In the last of this series the centrum (ib., 35) is reduced to the length of 1 inch, and the breadth of its front articular end to 6 lines. In the twenty-fifth caudal vertebra the centrum (ib., fig. 3) is 1 inch $10\frac{1}{2}$ lines in length, 1 inch 3 lines across the articular end, $7\frac{1}{2}$ lines across the middle, the longitudinal concavity of the sides exceeding that of the under surface. At the fore part of this surface the hæmapophysial articulation is barely indicated; at the back part it is marked by two surfaces (*h*), towards the most prominent part of which short, low ridges diverge. The low neural arch has coalesced with the upper three fourths of the centrum; the prezygapophyses (*z*) overhang the free fore part of the centrum, and extend beyond it to clasp the back part of the preposed neural spine. This is represented by a short, compressed ridge projecting above the part clasped by the prezygapophyses. The hæmal arch of the twenty-fourth caudal (ib., fig. 2, 24, *h*) underlies the centrum of the twenty-fifth; it presents a length of 1 inch 6 lines. Its closed base (ib., fig. 4) has a breadth of $7\frac{1}{2}$ lines; it presents a sub-bilobed form, concave transversely, convex from before backward. At the sides of the hæmal canal or rather slit, the arch has a fore-and-aft breadth of 4 lines, the spine expands to twice that extent, with an obtusely rounded termination. In the twenty-seventh caudal vertebra

the hæmal arch and spine are reduced to a length of 1 inch 2 lines; the spine progressively decreases to the thirty-second vertebra, beyond which the hæmal element ceases to be developed.

The centrum of the twenty-seventh caudal (Tab. IX, fig. 5, 27) is 1 inch 10 lines long; the anterior surface is 1 inch in depth, 1 inch 2 lines in breadth. The coalesced base of the neural arch has an extent of 1 inch; the prezygapophyses (z) are 9 lines in length; the neural spine (ns) is 1 inch in length above the zygapophysial surfaces, its summit penetrates the base of a superincumbent dermal bone, and the hæmal spine (h) has a similar relation to the dermal bone below. But both dermal bones may have been pressed nearer to the vertebra than in the living animal as the soft parts became dissolved away. The thirty-second caudal vertebra is 1 inch 4 lines in length, with a terminal breadth of 9 lines and a middle breadth of 6 lines. Its neural surface, showing the coalesced neural arch (n), from which the processes have been broken away, is figured in Tab. IX, fig. 6, the hæmal surface is represented at fig. 7, with the last hæmal arch (h), which is not quite closed above. The thirty-fourth caudal vertebra (ib., fig. 8), is 1 inch 2 lines in length; the breadth of its front articular end is 7 lines. The anchylosed neural arch has a basal extent of 9 lines; it is convex across the middle, like a saddle, rising into a short pyramidal process (ns) behind, like its peak; and still giving off the pair of long and slender prezygapophyses (z) from its fore part, which clasp the spine or peak of the antecedent vertebra.

The thirty-five caudal vertebræ, of which the principal distinctive characters have been above described, give a total length of 5 feet 8 inches 3 lines. The extent of dislocation between a few of these vertebræ would make a deduction of about 2 inches from the above extent; but the few vertebræ missing from the end of the tail, and reduced, as shown by parts preserved, to slender centrums, may, probably, have carried the length of the tail to about 6 feet.

The trunk-vertebræ include, as has been shown, four sacral, one lumbar, sixteen dorsal, and seven, or at least six, cervicals, and these vertebræ average each a length of 2 inches: the total length of the vertebral column of the trunk, estimated as including twenty-eight vertebræ, would be, on the above average, 4 feet 8 inches, or, allowing for intervertebral soft parts, 5 feet at the utmost in the recent animal.

The length of the head can scarcely have exceeded, more probably fell short of, 1 foot.

Thus we obtain an approximate estimate of the total length of the individual affording the before-detailed osteological characters of *Scelidosaurus* as not exceeding 12 feet from the snout to the end of the tail. But detached fragments of the fossilized skeleton of other individuals from the Lower Lias of Charmouth indicate a larger size, and that the present is not that of a mature Scelidosaur.

In the general osteological characters of the vertebral column we find this genus agreeing with *Hylæosaurus* and *Teleosaurus*.

None of the anterior vertebræ present the opisthocœlian modification characteristic of the Crocodilian genera *Streptospondylus* and *Cetiosaurus*, and in a minor degree of the Dinosaurian genera *Megalosaurus* and *Iguanodon*.

Not any of the anterior dorsal vertebræ developes the spinous process of so disproportionate a length as they present in the carnivorous *Megalosaurus*. Although the neural arch becomes loftier than *Crocodilia* in the dorsal region of the spine, the exterior of the peduncles or neurapophysial laminæ does not present the complex configuration produced by the strong, oblique ridges underpropping the diapophysis in *Iguanodon* and *Megalosaurus*. Upon the whole, I find the closest agreement to be between *Scelido-* and *Hylæo-saurus* in the characters of the vertebral column; and I infer for both, but especially for *Scelidosaurus*, a greater aptitude for swimming than in the larger *Dinosauria*.

Scapular Arch and Limb. Tabs. II and III.

The scapular arch has been compressed transversely to a degree which has produced fracture of the right coracoid (Tab. II, 52′), without material displacement in its relations to the left (Tab. III, 52 and 52′), but with corresponding approximation of the two scapulæ (Tabs. II and III, 51 and 51′), which have squeezed together, with some fracture and more dislocation, the interposed parietes of the thorax. The right scapula (Tab. II, 51) is least displaced; it extends along the first seven dorsal vertebræ, overlapping the spines of the last two. It is long and rather narrow; thickest above the humeral articulation, narrowest at its middle part, becoming broader and thicker towards its free end or dorsum, which describes a moderate and regular convex curve. The length of the bone to the fore part of its coracoid end is 13 inches; its least breadth is 2 inches; that of the base is 4 inches 10 lines. The body of the scapula describes a slight convexity outward in its course to the humeral joint, the expanded portion in front of which is gently excavated for a triangular space 4 inches long; the apex being upward, with a well-defined boundary, indicative of the attachment of a muscle to this part. The anterior border is almost straight through three fourths of its extent from the base, then becomes slightly concave to the anteriorly produced angle of the coracoid end. The posterior border is more deeply concave, through the production of the thickened part of the bone to form the humeral articulation (Tab. III, *h*). So much as is exposed of this surface is slightly concave transversely, slightly undulating in the opposite direction, 2 inches in breadth. The articulation (*c*) with the coracoid is a straight harmonia. At the upper part of the

humeral articular process there is an oblong notch, with slightly raised borders. The left scapula (Tab. III, 51) has yielded in two places to the external pressure, but without separation of the broken parts. It gives the same indication of the triangular muscular surface on the outside of its distal end as does the right scapula, the apex being defined by a better preserved, slightly raised, obtuse border. The fore part of the acromial end of the scapula (*a*), though fractured like that on the right side, is here better preserved, and gives a breadth of nearly 6 inches to this end of the bone. The humeral articulation (*h*) measures 2 inches 6 lines, the coracoid one (*c*) 4 inches. A small, oval, dermal bone (*d*), 1 inch 6 lines by 1 inch 3 lines, overlies the fore part of the scapulo-coracoid harmonia. It is flattened, slightly convex externally, like some others that seem to have defended the skin of the under surface of the trunk.

The coracoid (ib., 52) is an almost circular, flattened, discoid bone, 5 inches in antero-posterior diameter and 4½ inches in transverse diameter; the margin is most modified where it is expanded in 2 inches of its extent to contribute the coracoid portion (*h*) of the humeral joint. The scapular articular border (*s*) presents less thickness. The mesial or sternal border (*m*), continuing the circular curve, touches its fellow (52′) by only a small part of its circumference. The average thickness of the coracoid plate is 7 lines. About 1 inch 3 lines from the scapular surface there is a foramen, 5 lines in diameter. The free border of the entire coracoid appears to be raised, but this is due to the included surface having been crushed in and cracked by external pressure.

In the hinder interspace of the coracoids there is a flattened mass of a rhomboidal form, composed of scattered portions of thin, dark, osseous substance, cemented together by matrix, which is discoloured by carbonaceous material. No part shows the continuous, roughened, but compact, structure of the dermal bones. It appears rather to be the remains of some partially ossified element of the endoskeleton. In its position it corresponds with the sternum. There is a fainter trace of the same kind of material, or discoloration of the matrix, at the anterior interspace of the coracoids.

The humerus, which is preserved on the left side (Tab. III, 53) has been singularly crushed and flattened; the side of the middle of the shaft being broken away, exposes a small medullary cavity. The distal end (*d*) is broken off, and slightly overlapped by the shaft (53). The length of the humerus is 11 inches 3 lines. It presents a sigmoid flexure, the distal end slightly bent downward or forward; the proximal articulation, moderately convex, is 3 inches 8 lines in the long diameter; the fore part is produced into a strong ridge, here partly broken away. The distal end is 5 inches across, and is moderately concave transversely behind. An osseous tubercle, 1 inch 4 lines by 10 lines, is cemented to the anconal surface; a second similar bone is attached to the inter-

space between the inner condyle and the slightly dislocated ulna. These are more probably parts of the scattered dermo-skeleton than tendinal sesamoids of the extensor of the forearm

The acromial end of the ulna (Tab. III, 55) presents a convex border 2 inches 2 lines in breadth. The mutilated head of the radius (ib., 54), preserving its natural relations to the outer condyle of the humerus, is 1 inch 6 lines in length.

The shafts of the radius and ulna, with the rest of the bones of the fore limb, have been broken away.

Four oval, dermal bones, like those overlying the humerus and ulna, are attached to the matrix in front of the humerus and radius.

Behind the fractured sternal end of the right coracoid (Tab. II, 52) is the dislocated head (53) and anterior expanded pectoral process (*p*) of the right humerus (ib.), showing a thickness of 7 lines where it has been broken off. The transverse diameter of the humerus at this part is 6 inches, with a thickness of the shaft not exceeding 2 inches 9 lines, showing that the humerus in *Scelidosaurus* was more expanded and compressed proximally than in any existing reptile, and in this respect resembling the same bone in the Dicynodonts.

The proportions of the entire fore limb of *Scelidosaurus*, as indicated by the length of the humerus, would be those of the same limb in *Teleosaurus*. The humerus is shorter than the scapula, barely equalling the extent of four coarticulated middle dorsal vertebræ. There is no trace of clavicle in the present specimen; the functions of the fore limb seem, therefore, to have been less important in regard to locomotion on land than in Iguanodon, Megalosaurus, and modern Lizards. Yet the shape and proportions of the coracoid, as I pointed out in regard to the *Stagonolepis* when the remains and impressions of that reptile were submitted to my inspection by Sir Roderic I. Murchison, at Leeds, during the meeting of the British Association, September 24th, 1858,* show the distinction from the Crocodilian order and the affinity to the Thecodontian order and to modern Lacertilia, or give evidence of a more generalised reptilian character, in these extinct reptiles with dermal bones and scutes of the Lower Liassic and Upper Triassic deposits.

Pelvic Arch and Limb. Tabs. VI, X, XI.

The left iliac bone (Tab. VI, figs. 1 and 2, 62) retains almost its natural relations with the sacrum. The right iliac bone (ib., 62) has been obliquely dislocated. It is a long bone, with a sigmoid flexure (ib., fig. 2, 62), convex

* Art. "Palæontology," 'Encyclopædia Britannica,' vol. xvii, p. 130, in which, in reference to the Elgin matrix of *Stagonolepis*, it was stated that "no characteristic Devonian or Old Red fossils of any class have been discovered associated with the foregoing evidences of reptiles, which, according to the determination of strata by characteristic fossils, would belong to the secondary or mezozoic period."

upward and outward in its anterior two thirds, more slightly concave in the rest of its extent. Of the left ilium an extent of 18 inches is preserved, a part, apparently a small one, being wanting from both extremities. The narrowest portion of the bone is that which is produced anterior to the first sacral rib (ib., *s* 1); this portion is 6 inches in extent, triedral in form, 2 inches 6 lines in breadth where it joins the obtuse, expanded end of that rib. Beyond or behind the first sacral abutment the ilium progressively expands to a breadth of about 5 inches opposite the fourth abutment (*s* 4). The thickness of the bone, as exposed in the fracture of the left ilium, is from 2 inches to $2\frac{1}{2}$ inches. The middle third of the substance of the bone shows a rather open, cancellous structure; external to this the texture is much closer, with a compact, peripheral layer of from 1 to 2 lines in thickness. The articular cavity for the femur is on the under and outer side of that part of the ilium which is opposite its symphysis with the first two sacral vertebræ (*s* 1 and *s* 2).

The fore-part of the right ilium (62′), has been thrust away from that junction, and the femur (65) is dislocated, passing beneath the ilium, with the head abutting against the sacrum. The summit of the great trochanter terminates rather more than an inch below the articular head of the bone. The breadth of the femur across this part of the trochanter is 3 inches 6 lines. The length of the femur (Tab. X, fig. 1, 65) is 1 foot 4 inches. The inner process or ridge (*t*) begins to be developed about $5\frac{1}{2}$ inches from the head of the bone, and is 2 inches in extent. The shaft of the bone at this part is rather flattened, both anteriorly and posteriorly, and is most convex externally. It assumes a rounder circumference about 1 inch below the inner process, where the bone is 2 inches 4 lines in diameter. Thence it expands to the condyles (*a* and *b*), becoming flattened anteriorly and concave posteriorly. The condyles are but feebly indicated by a shallow notch on the fore part, but more distinctly behind, where they are produced backward. The hind extremity of the outer condyle (*b*) is marked off by a notch from the rest of its articular surface lying anterior and external to it. This posteriorly defined part articulates with the outer condyloid production of the head of the tibia, the fibula articulating with the rest of the outer condyle. The transversely convex fore part of the shaft of the femur is divided on each side by a low ridge from the flattened surfaces converging towards it, the one from the outer side, the other from the inner process (*t*). The exterior of these ridges is continued further down the bone than the opposite one. This femur, being broken across about 6 inches from its upper end, shows a medullary cavity of about $1\frac{1}{2}$ inch in diameter, with a compact and finally cancellous wall, which is nearly an inch in thickness next the base of the inner process, and is about 3 lines in thickness on the opposite side of the shaft (Tab. X, fig. 2). The transverse breadth of the shaft here is 2 inches 7 lines, the fore-and-aft breadth is 2 inches. The transverse breadth of the distal end is 4

length, and 1 inch in basal breadth; is sub-depressed, and curved downward. About 3 lines in advance of the joint, its breadth is increased by two lateral ridges. The apex is subacute. The under surface is marked by many fine, wavy ridges. There are two obtuse longitudinal prominences on the under surface near the joint, for the advantageous insertion of the flexor tendons, and there is a rough prominence at the middle of the dorsal surface, near the joint for the insertion of the extensor tendon. The dorsal surface near the margins and apex, is sculptured by vascular grooves. The total length of the first digit (*i*) is 6 inches.

The second metatarsal (ib., *ii*) is 5 inches in length; with a proximal articular surface 1 inch 6 lines in breadth, sinuous but almost flat; this surface presents almost double the transverse extent in the antero-posterior direction. The inner and anterior part of this surface is produced inward, or tibiad, apparently to afford an abutment or attachment, at least in part, to the proximal end of the first metatarsal. The outer or fibular side of the second metatarsal is almost straight, the inner or tibial one concave, the expansion at both ends taking place chiefly in that direction. The distal articular surface is convex from before backwards, with a median groove producing a transverse concavity between the two convexities or condyles, at the posterior half; and these slightly project backward. The first phalanx of the second toe is 1 inch 3 lines in length, 1 inch 7 lines across the proximal, and 1 inch 6 lines, across the distal end; the diameter from before backward at the middle of the shaft is 6 lines, the phalanx is consequently broad and sub-depressed. The posterior or plantal surface at the proximal end is slightly produced. The distal articular convexity extends a little way upon the middle of the dorsal surface, and slightly swells out into two condyles at the opposite surface. The second phalanx is much shorter in proportion to its breadth, which at the base is 1 inch 6 lines; the length being 1 inch 7 lines; the tibial border is short and concave; the fibular one is straighter and one third longer. The ungual phalanx (*ii*) differs chiefly from that of the first digit in its superior size, being 2 inches in length and 1 inch 4 lines in its greatest breadth; the fibular margin is convex, the tibial one slightly concave. A side view of the bone, of the natural size, is given at fig. 4, Tab. X.

The length of the third metatarsal (ib., *iii*) is 5 inches 4 lines. It is more symmetrical in shape than the rest. The transverse breadth of the proximal end is 1 inch 8 lines; the fore and aft breadth is 2 inches 1 line. The thickness in this direction diminishes rapidly towards the distal end; the transverse dimension decreases in a much less degree; this, at the middle of the bone, being 1 inch 2 lines, whence it increases to a distal transverse breadth of 1 inch 11 lines. The configuration of this articular surface resembles that of the second metatarsal; the fore and aft breadth of the condyle is 1 inch 6 lines. The proximal phalanx of the third toe (ib., *iii*, 1) is 1 inch 2 lines in length, 1 inch 10 lines across the base,

and 1 inch 3 lines across from before backwards. On the middle of the outer border is a tuberosity; each side of the distal end is deeply impressed; the distal articulation resembles that in the second toe. The greatest transverse breadth of this phalanx is 1 inch 7 lines. The second phalanx (ib., 2), with a basal breadth of 1 inch 6 lines, is only 1 inch 7 lines in length. The distal articulation is 1 inch 5 lines in breadth. The third phalanx (ib., 3), with a basal breadth of 1 inch 3 lines, is 1 inch 2 lines in length, with a distal breadth 1 inch 1 line. The ungual phalanx (ib. 4) is more depressed in proportion to its breadth than that of the preceding toe; in other respects it resembles it in shape.

The fourth metatarsal (ib., *iv*), is 4 inches 5 lines in length, of an unsymmetrical figure, receding from the middle metatarsal along its distal half, which is concave lengthwise on the tibial side; the fibular side presents a general but slighter concavity; this metatarsal is triedral, the fore and back surfaces converging to an obtuse, narrow, outer border, significant of its terminating that side of the foot beyond the representative style of the fifth digit (*v*). The fourth metatarsal measures 1 inch 9 lines across the base and 1 inch 7 lines from before backwards, at the tibial side of the base; the fibular side being reduced to the narrow rough ridge for the ligamentous attachment of the fifth abortive metatarsal. The breadth of the shaft of the fourth metatarsal at its lower third is 1 inch 1 line; that of the distal articular surface is 1 inch 5 lines. The first phalanx of the fourth toe is 1 inch 11 lines in length; the basal breadth is 1 inch 8 lines and the distal breadth is 1 inch 5 lines. The tibial angle of the proximal surface is most produced. The fore-and-aft dimensions of the shaft do not exceed 6 lines. The second phalanx is 1 inch 2 lines in length, and 1 inch 3 lines in basal breadth. The third phalanx is 1 inch in length, 1 inch 4 lines in breadth; the fourth phalanx is 9 lines in length, 1 inch 2 lines in breadth. The ungual phalanx is 1 inch 6 lines in length; 8 lines across its articular surface, 11 lines across its broadest part, caused by the aliform expansions of the bone beyond the articulation. It curves downwards and inwards, or towards the tibial side, to a subacute apex; the characters of its surface correspond with those of the larger ungual phalanges of the preceding toes.

From the abortion of the fifth digit, and the disproportionate shortness of the first, we have in *Scelidosaurus* the example of a reptile manifesting a tendency to the tridactyle type of the hind foot, and this is effected in its remote successor of the Wealden period,—the *Iguanodon*, by the suppression of the first, and by a similar atrophy of the fifth digit. The foot-prints of *Scelidosaurus* would terminate forward by the marks of four claws, the innermost falling short of the base of the second, this and the fourth reaching the same line, and the intermediate third claw extending farthest. The hind foot-prints of *Iguanodon* would be tridactyle.

The total length of the foot of *Scelidosaurus* is 1 foot 1 inch 6 lines; the

length of the leg ('cnemion') is 1 foot; the length of the thigh is 1 foot 4 inches; consequently the total length of the hind limb is 3 feet 5 inches; and, allowing for the fibro-cartilaginous matter of the joints and the terminal claws, the limb may have been 3 feet 8 inches long in the recent animal.

The femur equals the length of about seven co-articulated dorsal vertebræ, and, with the leg, manifests longer proportions to the body than in the *Crocodilia;* but the foot presents shorter and broader proportions although it has the same number of toes. *Scelidosaurus,* however, differs from *Teleosaurus* and modern *Crocodilia* in retaining the ungual phalanx of the fourth toe, as in modern lizards (Tab. XI, fig. 3, *i v*); although it differs from these and resembles the Crocodiles in the non-development of the fifth toe. The interesting evidence of this intermediate relationship afforded by the bones of the hind foot, as by some other parts of the skeleton, is illustrated by the outline figures of the skeleton of the hind foot (Tab. XI) in *Varanus,* fig. 3, in *Crocodilus,* fig. 4, and as similarly restored in *Scelidosaurus,* fig. 2.

In the same plate is figured, of half the natural size, the bones of the right hind foot of the skeleton of the Scelidosaur which has yielded the subjects of the present Monograph; showing the effects of pressure in fracturing and partially dislocating the metatarsal segment, after all the joints of the toes had been cemented by the surrounding hardened matrix in their respective varied numbers and co-adjustment in each toe.

Dermo-skeleton.

The bones belonging to this system were extensively developed in *Scelidosaurus,* and are for the most part of a massive character. They have been much displaced in the present specimen, partly during the decomposition of the carcass, and partly by subsequent pressure due to movements of the imbedding stratum; but retain their most intelligible natural relations to the endo-skeleton in the caudal region: in which part, therefore, I shall begin their description, as they were found, on exposing the vertebral characters on the left side, from the end of the tail forwards; and were either removed, or left *in situ,* as the case required.

At the thirty-first caudal vertebra, for example, there was attached to the back part of the neural arch, and pressed rather obliquely to the left side, an elongated triedral dermal bone, with the narrowest side or surface forming the base, and the two broader or larger lateral surfaces converging at an acute angle to an upper ridge. Much of this ridge on the fore part of the bone had been broken away in the original exposure of the specimen; the length of what remained was 1 inch 2 lines, with a basal breadth of 6 lines. The sides of the bone seemed as if

worm-eaten, by narrow curved grooves with intervening small, oblong, and circular pittings. The texture as exposed by the fracture was compact, reflecting a lustre. Between the twenty-ninth and thirtieth vertebræ there was the basal part of a similarly shaped dermal bone, 1 inch 9 lines in extent, with a basal breadth of 9 lines. It lies upon the right side of the coadopted halves of the neural arches of these vertebræ, but may have been displaced from the median line, and this is more probable as the base of a dermal bone crossing the articulation between the centrums of the same caudal vertebræ, has also been pressed towards the right side, on which the carcass of the reptile appears to have rested in the matrix. But any doubt as to the relations of the dermal bone above indicated was dissipated by the better preservation of those found in connection with the twenty-seventh and twenty-eighth caudal vertebræ (Tab. IX, fig. 2); and which are represented of the natural size in figure 5 of the same plate.

The dermo-neural bone (*d n*), was found fractured, with a slight displacement of the back part of its base: when entire, it had a longitudinal extent of 3 inches 6 lines, and a vertical one of 2 inches. The base is hollow, and has been crushed by the lateral pressure; but seems to have had a breadth of nearly an inch. The sides converge to the upper margin, which describes a bold convex curve from before backwards, along two thirds of the contour, and then descends in a straighter line obliquely backward to the hinder angle of the base. This dermal bone extends from above the prezygapophyses (*z*) of the twenty-seventh caudal vertebra to the fore part of the spine of the twenty-eighth. On removing part of the side of the base of the dermo-neural bone the spine (*n s*) of the twenty-seventh vertebra was seen to have penetrated the basal cavity, as far as that extended into the substance of the dermal bone; but I incline to think that fibrinous or other soluble tissue intervened in the living reptile, and that the position of some of the more anterior dermo-neurals, situated at a higher level above the neural spines, was the more natural one.

The dermo-hæmal bone (ib., *d h*) presents a longitudinal extent of 2 inches 3 lines, with a vertical one of 13 lines, and a basal breadth of about 9 lines. The hæmal spine of the twenty-seventh vertebra (*h*), seems also to have entered a hollow in its base, where it was exposed by removal of part of the left wall of the basal cavity. But this had been pressed up to the under part of the centrums, almost touching the posterior half of the twenty-seventh and the contiguous two thirds of the twenty-eighth caudal vertebræ; obliterating an interspace which should have been occupied by muscle, tendon, ligament, and other soft parts in the recent animal.

The dermo-hæmal spine below the twenty-fifth and twenty-sixth caudals differed only in its larger size from the succeeding one. Part of the base of the corresponding dermo-neural was preserved.

In the series of nine consecutive caudal vertebræ (Tab. IX, fig. 1), the number and disposition of the dermo-neural and dermo-hæmal bones were more fully and satisfactorily exhibited. Three consecutive dermo-neurals extended over a series of seven vertebræ, from near the fore part of the first to near the hinder half of the last of these seven; each extending over the interspaces of two vertebræ. The corresponding dermo-hæmals are of smaller size, cross only one intervertebral space, which is the second or posterior of those so crossed above, and their hinder end is a little further back than that end of their homotype above. But, in working out these vertebræ, indications of a third series of caudal dermal bones were first met with. There extended over the articulation between the twenty-first and twenty-second caudals the base of a dermal bone, 3 inches long, crushed, with its apical ridge broken off. On its removal, the vertebræ it crossed were seen to have been displaced to the extent of nearly an inch. The position of this bone, and the ascertained relations of the neural and hæmal dermal bones to their vertebræ, made it improbable that it was one of either of these series displaced; and attention was quickened, which led to the detection of a similar appearance further in advance, to be presently described.

The best preserved dermo-neural, in the series of nine caudal vertebræ (Tab. IX, fig. 1 *d n*), presents a basal longitudinal extent of 3 inches 5 lines, with a basal breadth of 1 inch 9 lines: its *quasi* worm-eaten, rugose sides, converge to an upper margin, not quite entire, but with apparently a contour resembling the dermo-neural in fig. 5. The present larger bone overlies the twentieth and contiguous portions of the nineteenth and twenty-first caudal vertebræ. The corresponding dermo-hæmal bone (*d, h*), with a longitudinal basal extent of 2 inches 6 lines, and a basal breadth of 1 inch 3 lines, underlies the twentieth and twenty-first caudals, extending along a greater proportion of the former. Its sides, similarly but more finely sculptured than the dermo-neural above, converge to a convex inferior border; the depth of the side being not less than 1 inch 6 lines. The next dermo-neural in advance overlies the eighteenth and contiguous half of the seventeenth caudal vertebræ. It presents a basal extent of 3 inches 6 lines, with a basal breadth of 1 inch 6 lines. The base of the corresponding dermo-hæmal spine is preserved, which underlaps the hinder two thirds of the eighteenth and the front third of the nineteenth caudal. Its base is 2 inches 7 lines in length, with a moderate contour. The apical ridge and left side of this bone have been broken away.

Between the above-described dermo-neural and dermo-hæmal bones there was the base of a lateral dermal bone, 3 inches 5 lines in length, applied over the eighteenth and part of the nineteenth caudal vertebræ, like that between the twenty-first and twenty-second. The portion preserved in exposing these vertebræ is figured in the interspace produced by their slight dislocation, into which it

had been wedged by pressure. I conceive it to have been the direct instrument of the dislocation, receiving and transmitting the extraneous pressure; and at a period when the vertebræ in front and behind were sufficiently free in their bed to allow of being pressed close together, with obliteration of their natural interspaces originally occupied by the soft inter-articular material; the extent of such interspace is probably shown between the twenty-second and twenty-third caudals (Tab. IX, fig. 1). From the evidence of the dermo-neurals and dermo-hæmals, *in situ*, in the present series of vertebræ, the dermal bone above described could not be one of either of these series displaced; and I infer from it, and the evidence of a similarly situated bone in a remoter part of the tail, that this appendage was defended by a series of lateral as well of upper and lower dermal ossicles, though, perhaps, in less number, and of a flatter figure, along the sides.

The next dermo-neural in advance overlaps the sixteenth and the contiguous half of the fifteenth caudal vertebræ; but its hinder end, as well as a part of its summit, are broken away. What remains, measures 3 inches 4 lines in length, with a basal breadth of at least 2 inches. The margin of the base of all the above-described dermo-neurals describes a gentle convexity.

As the dermo-neurals advance in position, they progressively acquire increase of basal breadth, to near the base of the tail, retaining the average length of $3\frac{1}{2}$ inches, with a small increase of height. Three dermo-neurals range along an extent of the five vertebræ (eleventh to fifteenth caudals) figured in Tab. VIII, fig. 3; and the same relative number and position are shown in the five antecedent caudals (ib., fig. 1, *d n*).

On the right or imbedded side of the vertebræ, overlying the centrum of the fourteenth, and contiguous parts of the thirteenth and fifteenth vertebræ, is the base of a dermo-lateral bone, 3 inches 3 lines in length, 2 inches 3 lines in breadth, the sides converging at an open angle, but with their terminal ridge broken off. This representative of the lateral series of dermal bones would seem to show that they had greater breadth and thickness than either those of the upper (neural) or lower (hæmal) dermal series. The right side, where these additional indications of a lateral series of dermal bones are preserved, was that which was left imbedded in the matrix; the left side being that which was exposed by the original quarrying operations. It is probable, therefore, that the dermo-lateral bones of the left side, with the exception of the few remains above noticed, were in the matrix so detached. The characters of the caudal vertebræ figured in Tabs. VIII and IX were displayed by careful removal of the matrix left adhering to the parts originally exposed; during which operation the portions of the dermo-lateral bones which had been pressed inward, and contributed to the dislocation of the twenty-first from the twenty-second, and of the eighteenth from the nineteenth caudal vertebræ, were brought to light.

A dermo-neural bone overlies the ninth and tenth caudals (Tab. VIII, fig. 1); another over the seventh and eighth (*d n*); a third over the sixth and fifth. The fracture through the middle of this latter bone (Tab. VII, fig. 3), shows the form and depth of the angular excavation at its base, which rested, probably with interposed ligamentous substance, upon the summit of the neural spine of the caudal. The corresponding dermo-hæmal bones, displaced so as obliquely to overlap the hæmal spines on the right side, are also preserved; and on this side there are as many dermo-lateral scutes, but more fragmentary and dislocated.

In the block of lias with the first five caudal vertebræ (Tab. VII, figs. 1 and 2), is the anterior half of the dermo-neural overlapping the fifth and sixth of that series. Two similar bones with a basal excavation exposed by fracture in one of them, are situated to the right side of the fourth and third caudals, which may be dermo-laterals or displaced dermo-neurals. A portion of a massive dermal bone lies upon a part of the ilium contained in this slab. The rest of the armour of this part of the base of the tail has been removed. The like is the case with regard to the upper part of the block including the sacrum (Tab. VI). At its under part, in which are imbedded dislocated bones of the hind limbs, there are a few scattered portions of wedge-shaped dermal bones, similar in size to those at the base of the tail, but less pyramidal, and with more obtuse summits. A few smaller, flatter, subcircular dermal bones were met with in the course of exposing the parts of the endo-skeleton. One of these (ib., *d*), lies above the interspace between the left ilium and the third sacral rib (Tab. VI, fig. 1, *d*).

In the block of lias containing the fore part of the thorax and scapular arch a longitudinal series of eight dermal bones were found on the right side, overlapping the ribs, external to the diapophyses. These dermal bones were shorter and thicker than the caudal dermo-neurals, and had been subject to more or less fracture and some displacement. The best preserved was wedge-shaped, with the sides of the excavated base slightly convex, 2 inches in length, 8 inches 9 lines in breadth, the sides converging at a more open angle, but unequally, to a margin which shows a convex ridge. The inferior size and unsymmetrical shape of this bone seem to show that it formed part of a lateral row, which had been situated near a middle one, or had ranged along near the medial line of the back. The margins of these bones were not entire. The summit of a dermo-neural spine remains wedged between the spines of the second and third dorsals, and another between those of the fourth and fifth dorsals (Tab. II, *dn*, *dn*). On the left side of the thorax (Tab. III), are preserved some of the upper lateral series of dermal bones (*d n l*), showing their natural position and intervals. On the same side, beneath the foregoing (Tab. III, *d l*) are some larger wedge-shaped dermal bones. Three of these may have been displaced from above the neural spines. They are elliptical; 3 inches long, 2 inches broad at the base, with the sides converging

with a slight concavity to the upper ridge, which has been broken off in each, so that its height is conjectural. Other evidences of dermal bones on the under part of this slab are too fragmentary and scattered to throw any light upon their natural arrangement. On the right side (Tab. II), overlying the ends of the ribs, about ten inches distant from the vertebræ, are preserved three of a series of flattened, sub-ovate, dermal scutes (*d a*, *d a*), about 3 inches by 2 inches in the long and cross diameters, and from 2 to 4 lines in thickness. The outer surface exhibits the same character of sculpturing as do the dermal bones of the tail; the inner surface is smooth.

In the block containing the second and third cervical vertebræ the pair of lateral, unsymmetrical, dermal bones have been preserved nearly in their natural position. They are three-sided; the shortest is directed towards the intervening vertebræ; the side next in length looks downward; the outer surface, directed upward and outward, is the most extensive. These scutes have been fractured through their centre. They show an external, very compact, layer of bone, thickest on the outer or peripheral side. The rest of the bone shows a rather close cancellous structure. Above these, but slightly displaced, is a pair of wedge-shaped bones, which are probably dermo-neurals, indicative of a parial arrangement of these along the nape, contrasting with their single series above the tail. Each of these dermal bones are somewhat unsymmetrical in form, 2 inches 9 lines in the length of the base, 1 inch 9 lines in breadth, with the median surface more extensive than the outer, and both converging to a ridged summit, but which is broken away.

The anterior pair of nuchal scutes is preserved in connection with the occiput, overlapping the atlas (Tab. I, fig. 1, *dn*, *r*). They are similar in shape, but smaller in dimensions, than those last described, and have been broken across.

From the sum of the foregoing observations, it may be inferred that the surface of the Scelidosaur was defended by several longitudinal series of massive dermal bones, those occupying the median and upper surface being arranged in pairs upon the nape and singly along the tail. External to these were a lateral series, at least two in number but probably more, on each side the trunk, having the same wedged and ridged shape as the dermo-neurals. Beneath these were flattened, ovate scutes along the lower lateral part of the thoracic-abdominal region. In the tail we have more decisive evidence of a single median row of large, symmetrical, cuneiform, hollow-based, superiorly ridged dermo-neurals, with dimensions making three occupy the space of five vertebræ along the base of the tail, and nearly seven vertebræ along the hinder half of the tail. There was a corresponding median series of smaller and less vertically extended dermo-hæmal bones, and also a single series of dermo-laterals, of more depressed and fuller ovate form, on each side.

The accidents attending the decomposition of the carcass of this reptile seem

to have had the chief share in the removal and displacement of so large a proportion of its coat of mail. Subsequent cosmical violence has been concerned in the fracture, the crushing, and in a certain amount of displacement of the constituent parts of the skeleton. Lastly, further fracture of the fossil bones has been due to the quarrying operations, by which the specimen was brought to light.

Conditions of imbedding and deposit.

The general condition of this almost entire skeleton of a reptile, organized, as seems by the structure and proportions of the hind foot, for terrestrial rather than aquatic life, or at least for amphibious habits on the margins of a river rather than for pursuit of food in the open sea, I infer that the carcass of the dead animal has been drifted down a river, disemboguing in the Liassic ocean, on the muddy bottom of which it would settle down when the skin had been so far decomposed as to permit the escape of the gases engendered by putrefaction. In that predicament the carcass would attract large carnivorous marine fishes and reptiles, and portions of the skin, with prominent parts not too strongly attached to the trunk, would probably be torn away before the weight of the bones had completely buried the carcass in the mud. In this way, perhaps, we may account for the loss of much of the dermo-skeleton and of the two fore paddles. The larger hind limbs with their stronger muscles and ligaments, would offer better resistance to such predatory attacks; and they, at any rate, have been preserved. The agitation to which the body must have been subject in its course down the stream, and before it finally sunk and settled out of sight, would be attended, after a certain amount of decomposition of the flesh, ligaments, and other soft parts, with such an amount of dislocation as the ribs and other parts of the vertebral column exhibit along the otherwise well-preserved and completely consecutive series of the bony segments, from the skull to near the end of the tail. But the oblique compression of the skull, the flattening of the thorax, squeezed between the approximated piers of the scapular arch, attended with fracture of one of the coracoids, and other indications in the rest of the trunk, plainly bespeak the enormous pressure to which the fossil has been subject after its imbedding, and which must have been attended with still more injury and destructive obliteration of anatomical characters had it not been for the surrounding uniform support afforded by the matrix, compactly hardened around the petrified skeleton before those cosmical movements commenced to which the change in the position of the old Liassic sea-bottom has been due.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

KIMMERIDGE CLAY.

PLIOSAURUS GRANDIS.

PLESIOSAURUS GRANDIS, *Owen.*	'Report on British Fossil Reptiles,' 8vo, 1839, p. 83.
PLIOSAURUS — *Owen.*	Ibid., 1840, p. 54.

The publication by the Palæontographical Society[1] of the evidence of the bulk of the *Pliosaurus,* afforded by a tooth of the *Pliosaurus grandis* in the Palæontological Collection of the Hon. Robert Marsham, attracted the attention of other geologists and collectors of fossils to the subject, and stimulated the possessor of a rich series of Pliosaurian remains from the Kimmeridge Clay at Kimmeridge, J. C. MANSEL, Esq., of Whatcombe, Dorsetshire, to transmit to me the magnificent tooth which forms the subject of Plate XII.

This tooth exemplifies its most perfect state of formation; the entire fang, or root, has been developed, and the unworn state of the crown shows that the time had not arrived for the absorption of the root through pressure of a successional tooth, which undermining process is usually concomitant with the loss of efficiency of the dental instrument through the wearing down of the crown.

This tooth accordingly presents a total length of 1 foot, one third of which is formed by the enamelled crown, the other two thirds by the cement-covered root. This part expands for the first half of its extent to a diameter of 3 inches, which is the thickest part of the tooth, and then gradually contracts to

[1] Volume of the Palæontographical Society, 1861, p. 15.

the thin borders of the base of the pulp-cavity, where probably an additional inch of the length of the tooth has been broken away. The characteristic Pliosaurian modifications of the coronal enamel—smooth on the outer or longitudinally convex side (fig. 2), and boldly ridged on the front (fig. 1) and back (fig. 3) sides—are so truly and sharply delineated by Mr. Dinkel's skill as to dispense with verbal illustration.

In comparison with the tooth from the Kimmeridge Clay near Oxford (p. 15, Tab. VII, of a former Monograph),[1] the crown in the present specimen, from the same formation at Kimmeridge, Dorsetshire, is shorter in proportion to its breadth, especially taken from the outer to the inner side of the base of the crown, and there is a difference in the number and disposition of the ridges, but neither of these amount to a distinction of specific value.

[1] Tom. cit., Tab. VII.

TAB. I.

Scelidosaurus Harrisonii.

Cervical vertebræ; nat. size.

Fig.

1. Vertical transverse section of the atlas, and of the superincumbent pair of nuchal dermal bones (*dn, r*).

2. Under surface of the axis and third cervical vertebræ, with the ribs of the atlas and axis.

3. Under view of the sixth (?) cervical vertebra, below which is the anterior articular surface of the centrum.

4. Posterior fracture of the same vertebra, showing part of the articular surface of the centrum.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

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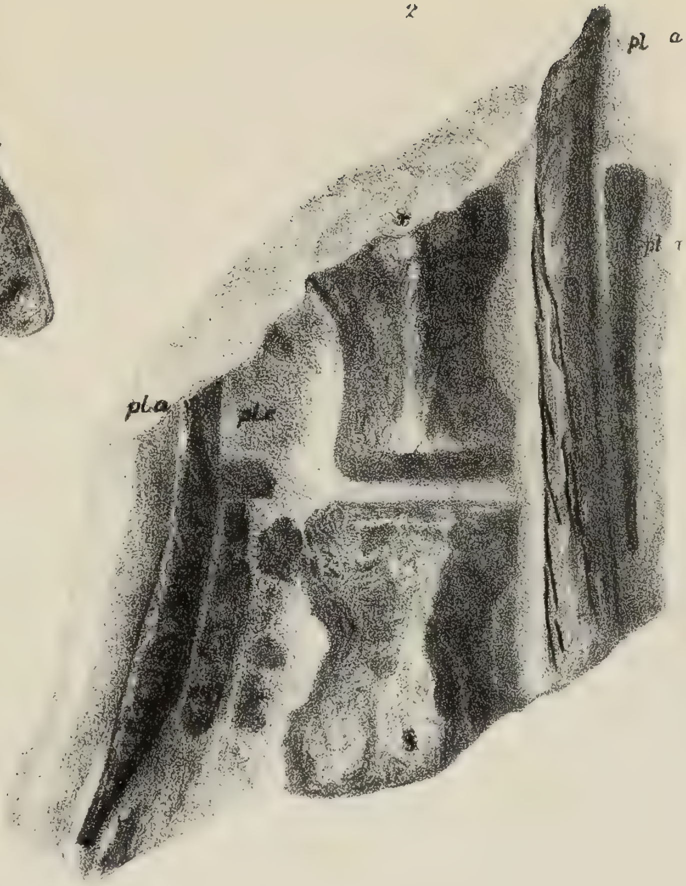

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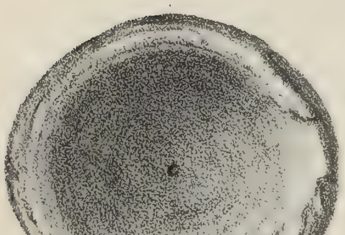


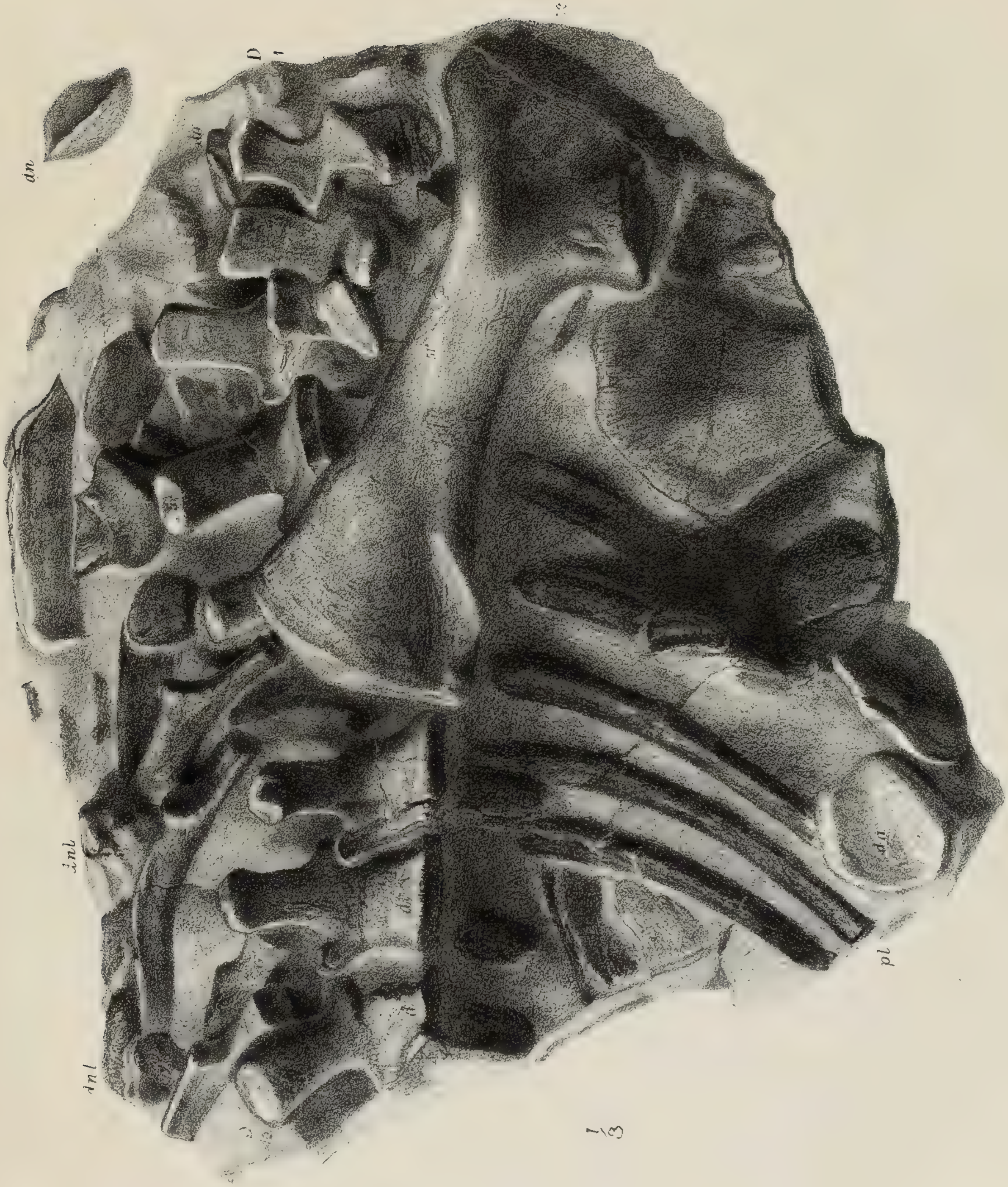
Jos. Dinker

TAB. II.

Scelidosaurus Harrisonii.

Right side of the thorax, with the ten anterior dorsal vertebræ and the scapula; one third nat. size.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.



Jos Dinkel del

W West, imp

TAB. III.

Scelidosaurus Harrisonii.

Left side of the thorax and scapular arch, with the humerus and dermal bones; one third nat. size.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

Dinkel del

TAB. IV.

Scelidosaurus Harrisonii.

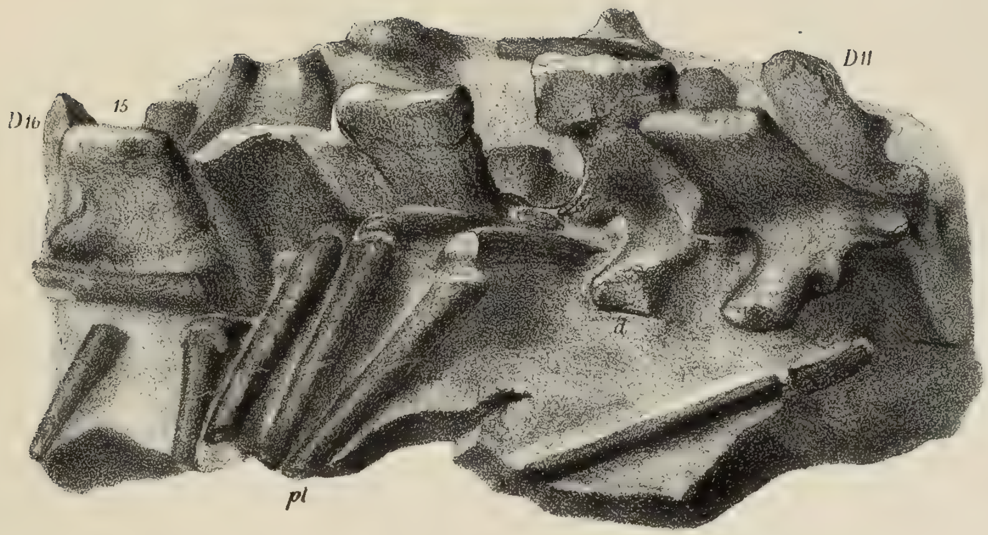
Dorsal vertebræ; one third nat. size.

Fig.
1. Right side of parts of the five last dorsal vertebræ.

2. Left side of the same vertebræ.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

1



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TAB. V.

Scelidosaurus Harrisonii.

Dorsal and caudal vertebræ; nat. size.

Fig.

1. Anterior surface, abraded on the centrum, of the eleventh dorsal vertebra.

2. Vertical transverse section of the sixteenth dorsal vertebra.

3. Ditto of the centrum of the fifteenth caudal vertebra.

4. Hinder articular surface of the twenty-eighth caudal vertebra.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

Jos Dinkel del

W. West, imp

TAB. VI.

Scelidosaurus Harrisonii.

Pelvis; one third nat. size.

Fig.

1. Upper or dorsal view of the sacrum and iliac bones, with the single lumbar vertebra (L) and part of the last dorsal (D 16).

2. Left side view of the ilium and sacrum.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

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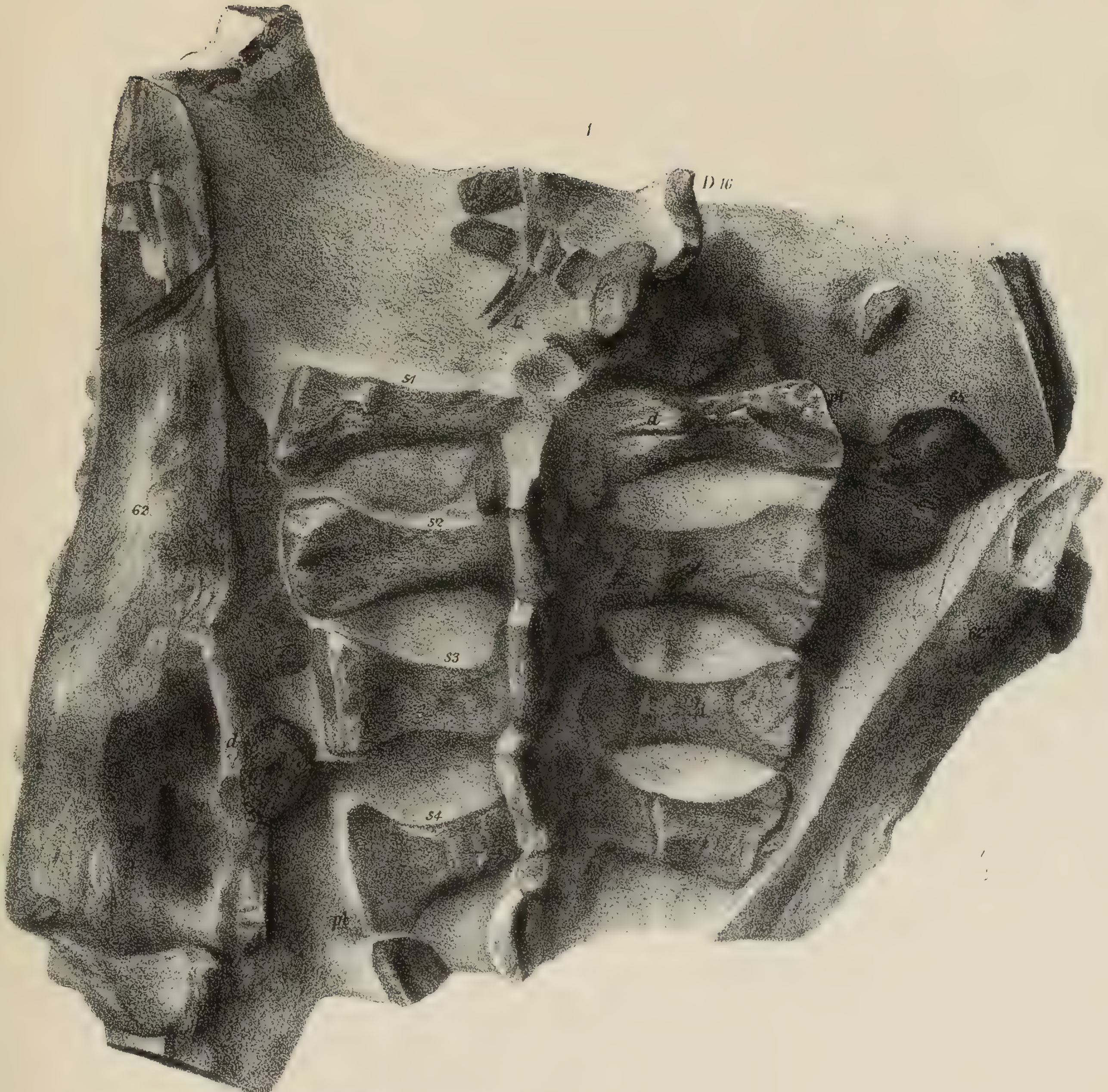

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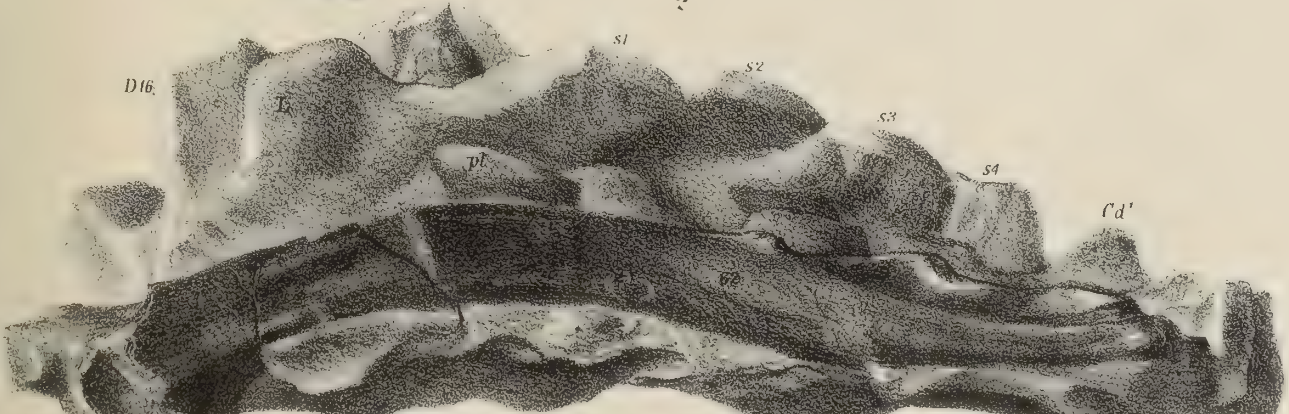

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TAB. VII.

Scelidosaurus Harrisonii.

Caudal vertebræ; one third nat. size.

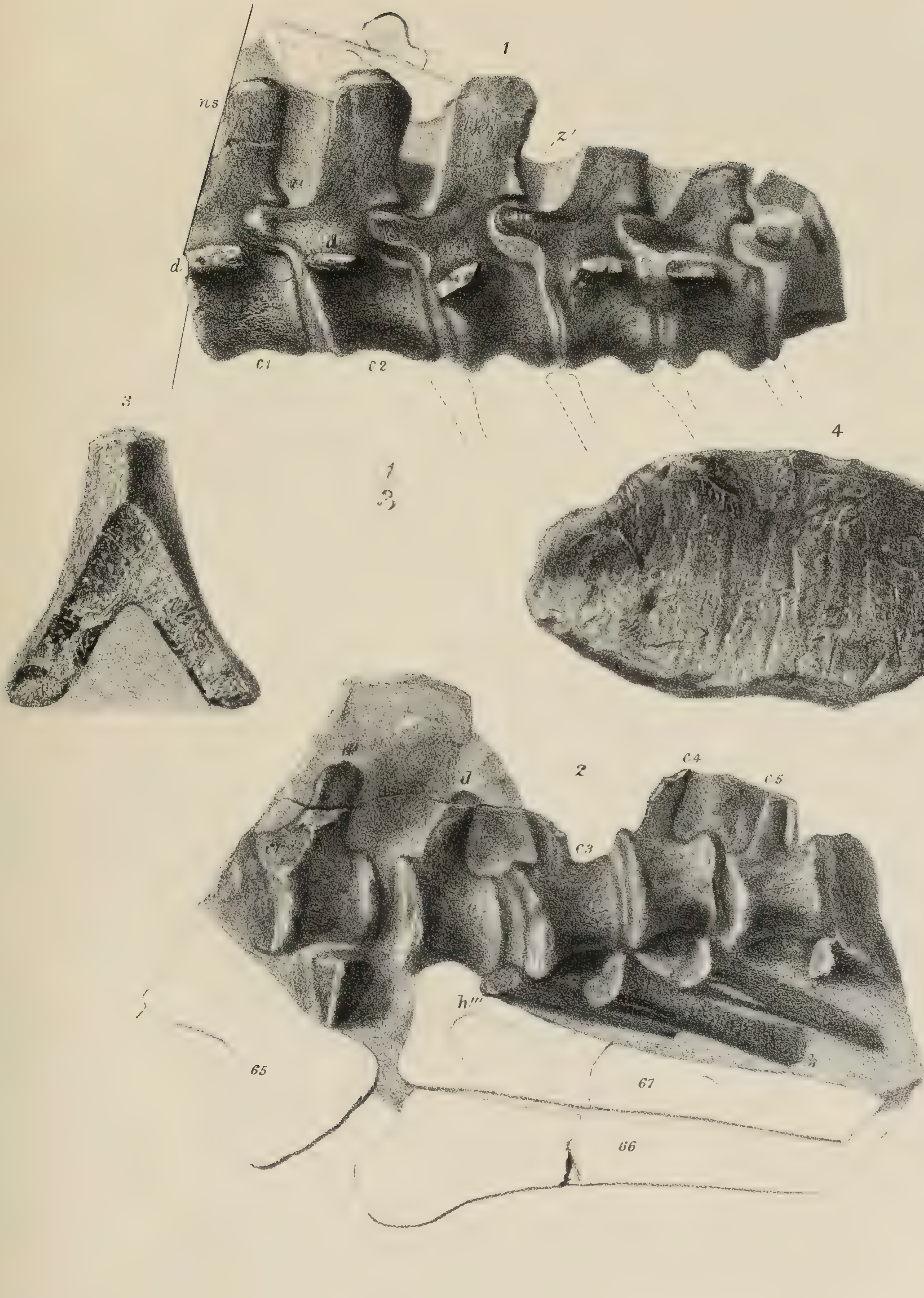
Fig.
1. Left side view of the first five caudal vertebræ.

2. Oblique under view of the same vertebræ, with outlines of the contiguous limb-bones.

3. Fractured fore part of an anterior caudal dermo-neural bone.

4. Side view of an anterior caudal dermo-neural bone.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.



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TAB. VIII.

Scelidosaurus Harrisonii.

Caudal vertebræ; one third nat. size.

Fig.

1. Oblique under view of the sixth to the tenth caudal vertebræ, and side view of three contiguous dermo-neural bones.

2. Upper view of the ninth caudal vertebra.

3. Oblique under view of the eleventh to the fifteenth caudal vertebræ.

4. Side view of the eleventh caudal vertebra.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

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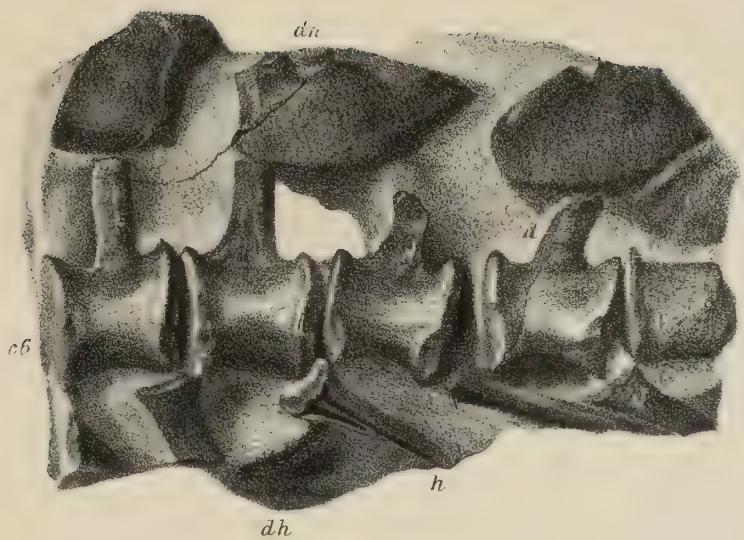

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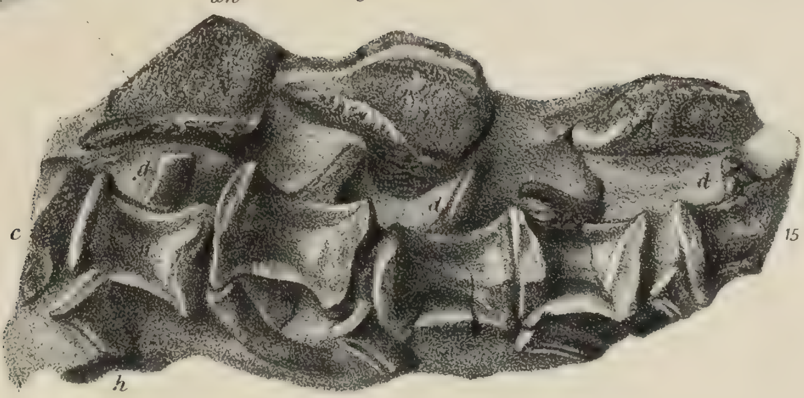

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TAB. IX.

Scelidosaurus Harrisonii.

Caudal vertebræ and dermal bones.

Fig.

1. Left side view of the sixteenth to the twenty-fourth caudal vertebræ, with contiguous dermal bones; one third nat. size.

2. Left side view of the twenty-fifth to the thirty-fifth caudal vertebræ; one third nat. size.

3. Under view of the centrum of the twenty-fifth caudal vertebra; nat. size.

4. Articular surface of the hæmal arch of the twenty-fifth caudal vertebra.

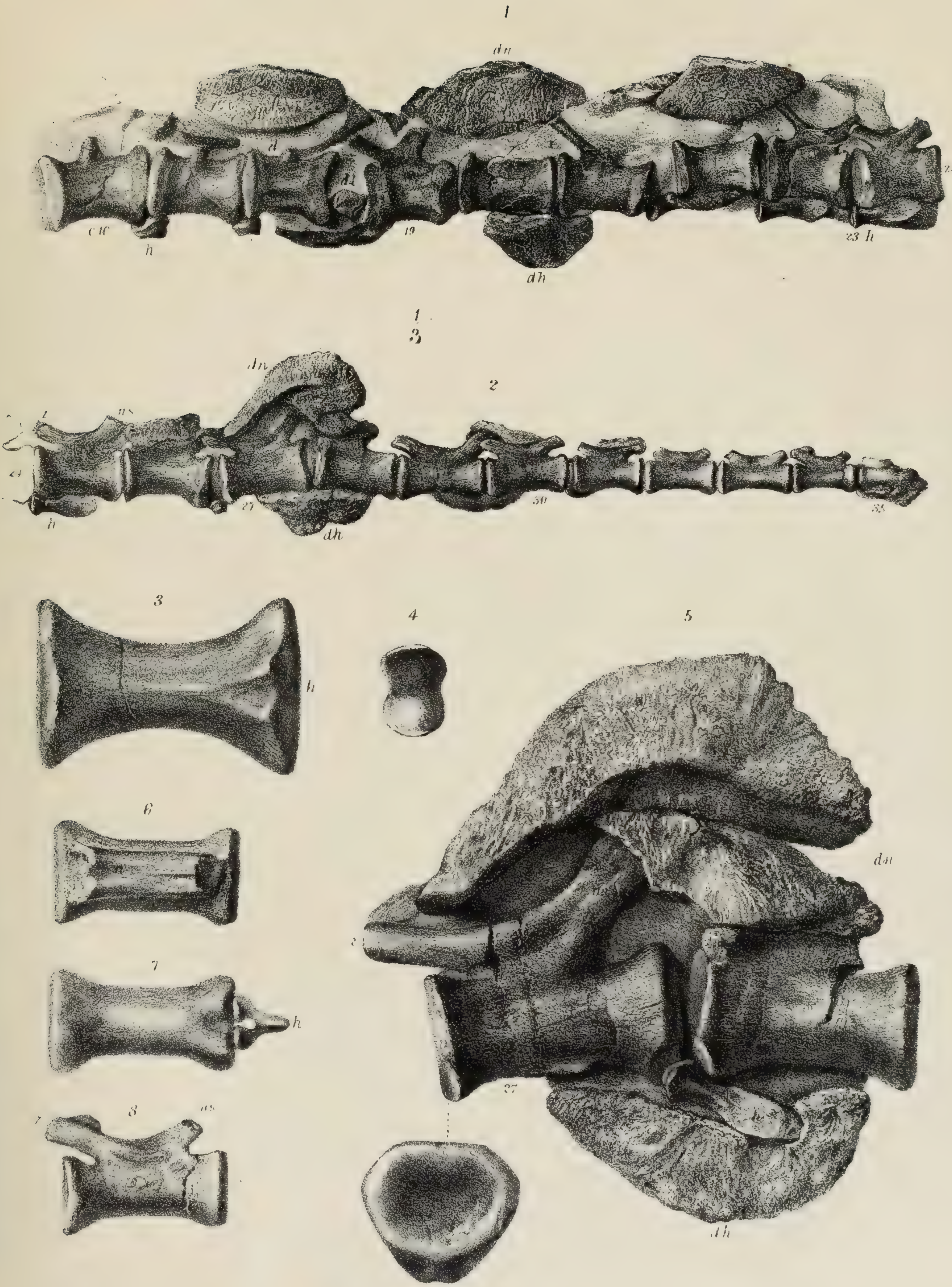
5. Left side view of the twenty-seventh and twenty-eighth caudal vertebræ, with their associated dermo-neural (*dn*) and dermo-hæmal (*d*) bones; the anterior articular surface of the centrum of the twenty-seventh caudal vertebra is figured beneath; nat. size.

6. Upper view of the thirty-second caudal vertebra.

7. Under view of the same vertebra, with the hæmal arch (*h*).

8. Side view of the thirty-fourth caudal vertebra.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.



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TAB. X.

Scelidosaurus Harrisonii.

Bones of the left hind limb; half nat. size.

Fig.

1. Outer and anterior view of the bones in their natural relative position, as they were exposed in the matrix.

2. Transverse section of the shaft of the femur, showing the medullary cavity; nat. size.

3. Bones of the left hind foot, from the posterior or plantar aspect.

4. Side view of the ungual phalanx of the third toe; nat. size.

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

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Jos Dinkel del

W West, imp.

TAB. XI.

Scelidosaurus Harrisonii.

Bones of the right hind foot; half nat. size.

Fig.

1. Bones of the right hind foot, with the distal ends of the tibia and fibula, showing the amount of dislocation with which they became finally petrified in the matrix.

2. Scheme of the bones of the hind foot, restored.

3. Scheme of the bones of the hind foot of a monitor lizard (*Varanus*).

4. Scheme of the bones of the hind foot of a crocodile (*Crocodilus*).

From the upper part of the Lower Lias, Charmouth, Dorsetshire. British Museum.

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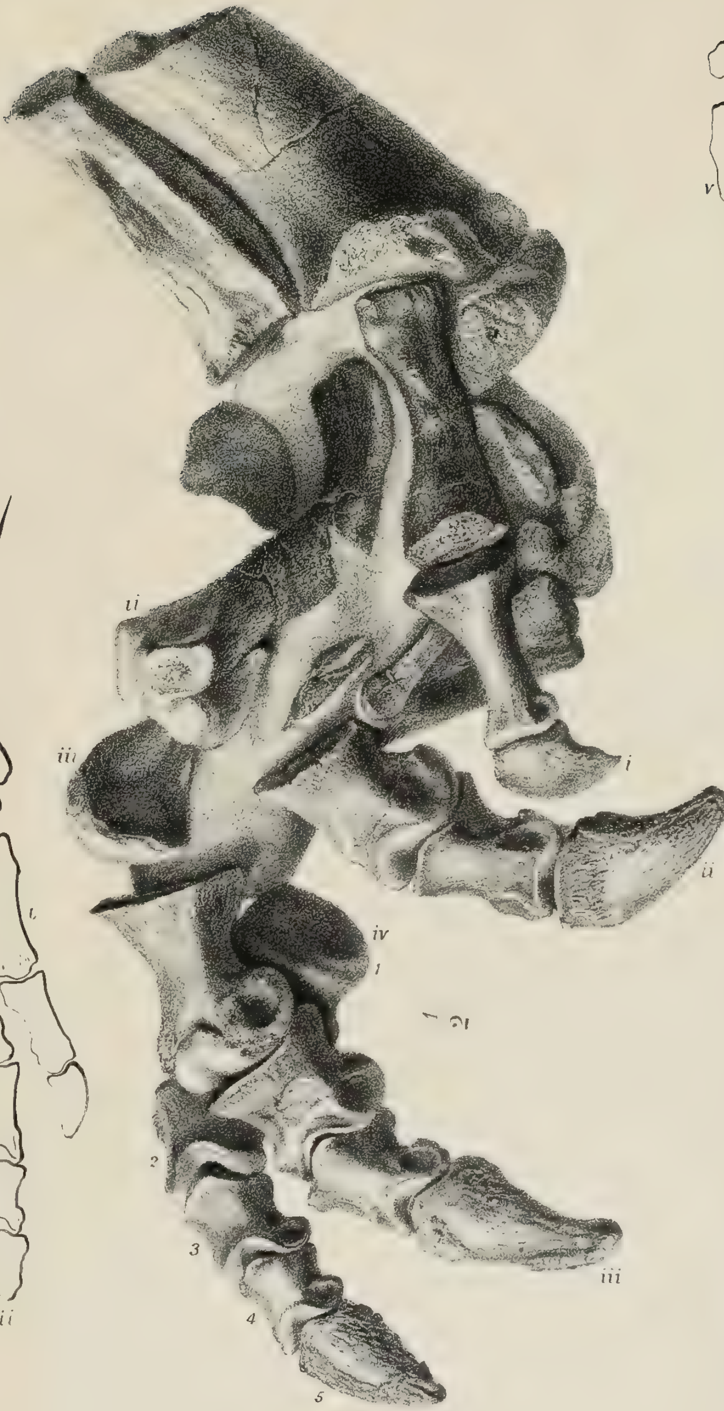

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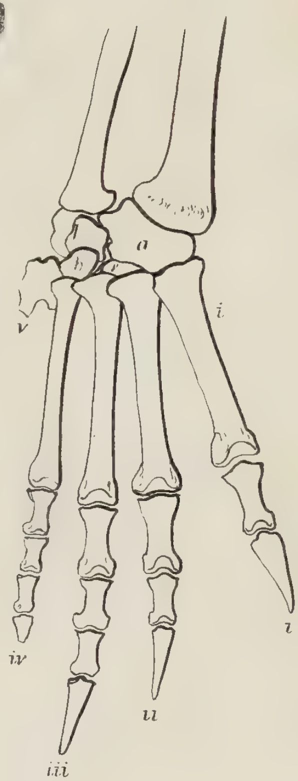


Jos Dinkel del.
W West imp.

TAB. XII.

Pliosaurus grandis.

Tooth ; natural size.

Fig.

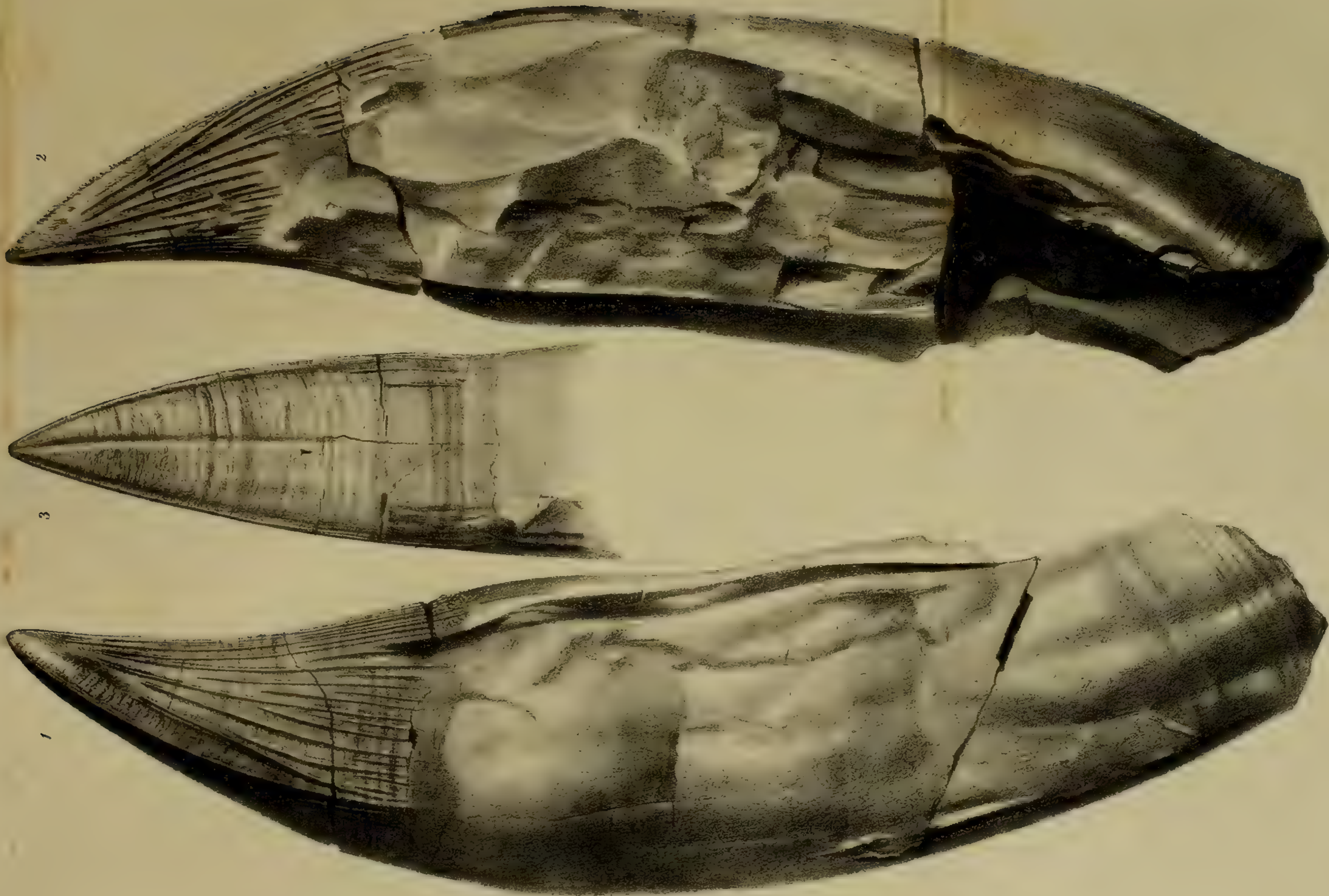
1. Anterior surface, with ridged coronal enamel.

2. Posterior surface, with ridged coronal enamel, somewhat crushed and mutilated.

3. Convex or unridged side of the crown.

From the Kimmeridge Clay, at Kimmeridge, Dorsetshire. Presented by the discoverer, J. C. Mansel, Esq., of Whatcombe, Dorsetshire, to the British Museum.

T. XII



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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

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A MONOGRAPH

OF THE

FOSSIL ESTHERIÆ.

BY

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PREFACE.

The materials of this Monograph have been accumulating for more than ten years; but the obscurity of some of the specimens, and the necessity of obtaining direct information from friends, both at home and abroad, acquainted with these fossils and the strata in which they are found, have caused considerable delay. Other interruptions, especially of late, have also thrown me off the study. Still the protracted time has brought many new facts to light regarding *Estheriæ,* both recent and fossil, as well as several new species and varieties.

I have been careful to give a full account of localities, and of sections in particular, that enquirers may seek for more specimens, and that they may be still more careful than heretofore in noting the exact contents and characters of the Estherian and associated strata. As fossil *Estheriæ* occur mostly in the passage-beds between the great Formations, and in the estuarine and freshwater equivalents of the marine portions of those Formations, the exact study of the Estherian beds cannot but prove of value in Geology, though the correlation of the beds may be somewhat difficult. The early appearance and long continuance of the Estherian type, and its wide distribution, are subjects of great interest to the Palæontologist.

I have a host of friends and kind helpers to thank for the assistance which they have rendered me, in various ways, always readily, and often at a considerable cost of time and

labour. Amongst my foreign friends I reckon some who gave early attention to the Triassic *Estheria minuta,* especially the late much lamented H. G. Bronn, the veteran F. von Alberti, and Naumann, as well as Geinitz, Beinert, Dunker, F. Sandberger, Oppel, Krantz, Hassencamp, Daubrée, Schimper, Engelhardt, E. d'Eichwald, Pander, G. von Helmersen, C. M. Wheatley of Pennsylvania, and W. B. Rogers of Boston, whose brother, Professor H. D. Rogers (Glasgow) has also eminently aided me. The late Mr. P. Duff, Dr. Mantell, and Prof. Quekett, Dr. W. Baird, Sir C. Lyell, Sir R. I. Murchison, the Rev. Messrs. Symonds, Brodie, Hislop, Austen, and Fisher, Dr. Oldham, Prof. Morris, Mr. Binney, Mr. G. Tate, Mr. Salter, Mr. Peach, Mr. J. Miller, Prof. W. C. Williamson, Messrs. S. P. and H. Woodward, Mr. D. Forbes, Mr. Rofe, Mr. Grossart, Dr. Rankine, Mr. Leckenby, Mr. Bean, Prof. Tennant, Mr. E. Hull, Mr. Etheridge, Mr. Kirshaw, Mr. C. Moore, Mr. Beckles, Dr. T. Wright, Mr. J. Plant, Mr. G. E. Roberts, Mr. C. E. Austin, and Mr. H. Seeley, must be enumerated as sources either of material or information for this MONOGRAPH ; and my friend, Mr. G. West, must be especially thanked for the patient care bestowed on the drawings, and for the great skill with which he has helped me most materially in unravelling many obscure points of structure.

Some of the best and rarest of the specimens illustrated in this MONOGRAPH are in the British Museum, the Museum of the Geological Society, and that of the Geological Survey : to the officers of these Museums my thanks are especially due.

To render the history of *Estheria* as complete as circumstances permit, I have described, in an APPENDIX, those other fossil bivalved *Entomostraca* that are in direct association with the *Estheriæ,*—that is, occurring in the same strata. I hoped that they might throw additional light on the habitats of the ancient *Estheriæ* ; the results, however, are not conclusive ; but will probably be found useful.

CONTENTS.

APPENDIX.

ERRATA ET CORRIGENDA.

Page 3, line 24 from the top, *for* Northumberland *read* Berwickshire.

Page 4, lines 2 and 3, *for* age (probably Tertiary) in Siberia, &c., *read* age in Siberia (Tertiary ?) and South America (Mesozoic ?).

Page 5, line 10 from the top, for *Estheria* read *Estheriæ.*

Page 20, lines 8 and 27, *for* Colonel *read* General.

Page 37, line 11 from the top, *for* Salbach *read* Sulzbach.

Page 38, last line, and page 40, line 22, for *Cytheropsis* read *Beyrichia.*

Page 41, line 20 from the top, *for* localities *read* locality.

Page 45, line 11 from the top, after *Estheria insert* (very rarely).

Page 49, last line, *for* From *read* According to.

Page 52, lines 8, 10, and 11, *transpose* [3] from *Albertii* to Soultz-les-Bains; and [4] *from* remains *to Albertii.*

Page 65, line 14 from the top, *for* above *read* about.

Pages 67, 69, and 71, in the heading, *add* VAR. BRODIEANA *after* MINUTA.

Page 81, line 19, *after* Proportion *insert* 3 to 5 or.

Page 87, line 21, *for* marls *read* shales, *and for* shales *read* slates.

" last line of the notes, *for* this *read* the.

Page 88, line 23, *insert* a comma after *Estheriæ,* and *dele* the comma *after* sandstone.

Page 89, line 21, *for* Dan River *read* Deep River. (The section of Egypt Pit ought to come in at page 90, after the table of the "Chatham Group.")

Page 91, line 15 from the top, *after* Deep River Series *insert* See Appendix for a notice of *E. ovata* from this series.

" line 17, for *trigonalis* read *triangularis.*

" line 29, for *angularis* read *triangularis.*

Page 95, in the section, *insert* 25 *between a* and 24.

A MONOGRAPH

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FOSSIL ESTHERIÆ.

INTRODUCTION.

Geologists, looking at fossils as witnesses of the varied conditions of land and water in remote times, desire to inquire fully into the probable habits and relationships of every organic relic of the past. Fossil shells, forming the chief portion of the materials in the hands of the palæontologist, become especially the subject of such inquiries, and are made to yield evidence as to the relative age and the mode of formation of the several strata in which they occur. It is by comparing the extinct shells with those now living, and assuming for the fossil mollusc habits similar to those belonging to the most nearly allied of its existing congeners, that geologists for the most part form a judgment as to the character of many strata, whether they were marine or fluviatile in their origin, whether formed in shallow or in deep water. We are not surprised that the evidence thus obtained should often be weak and occasionally faulty, seeing that mere similarity in the form of shells has sometimes to be taken as evidence of generic relationship or of specific identity; whereas the soft parts of the mollusc, now lost, might have borne other evidence.[1] In nothing are naturalists so much deceived as by the manifold mimetic resemblances occurring throughout all kingdoms of nature. These are not wanting between

[1] A marked instance of palæontological uncertainty as to the relationships of certain bivalves occurs in the case of some of the "Rhætic" fossils, thus alluded to by Mr. Charles Moore, in the 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 502, when describing them under the generic name "Axinus, Sowerby:"—"Few shells have been subject to greater transposition, or have been placed under so many different

different groups of the molluscs themselves,[1] and they are very striking in the case of certain Bivalved Crustaceans (forming the subject of this monograph), closely resembling in general form some of the Molluscous Bivalves. A glance at the accompanying plates illustrating some fossil Bivalved Crustaceans reminds us of many well-known forms of Lamellibranchiata, such as *Posidonomya*, *Modiola*, *Myacites*, *Anodon*, *Unio*, *Cyclas*, *Pisidium*, *Kellia*, *Turtonia*, *Nucula*, and others; and indeed some of the species here figured have been referred by palæontologists to *Posidonomya* and other molluscs. It has, however, generally been felt that there was a difficulty in the exact determination of these little shells; still a rigorous examination of their form and structure was wanting, the pocket-lens only, and not the microscope, having been brought to bear on them.

Being subjected to the microscope, and drawn by means of the camera-lucida, many of these minute shells no longer appear with the outlines given to them by older plates and woodcuts; thus, *Estheria membranacea*, when perfectly portrayed, is no longer the triangular "Cyclas" or "Venus" of older figures, but has a semi-orbicular Posidonomya-like form. On the other hand, *E. minuta* has more of the Pisidium-shape than its old name "Posidonomya" would indicate. The microscope, moreover, exhibits the peculiar superficial ornament so characteristic of the Bivalved Crustacea, and wanting in the Mollusca; but of this ornamentation of the *Estheriæ* we had at hand the published illustrations and descriptions, by Dr. W. Baird, in the 'Zoological Society's Proceedings,' 1849, &c.;

genera, as those included in the group under notice. Von Credner, in 'Leonhard und Bronn's Jahrbuch,' 1860, p. 307, remarks that one of the Rhætic species has by Roemer been called *Venus liassica*, but without a figure; by Quenstedt, in 'Der Jura,' *Opis cloacinus;* that Escher notices it, but without naming it, from the Kössen beds; by Oppel and Suess it is called *Schizodus cloacinus;* and that it had previously been given by Bornemann, but without a figure, as *Tæniodon Ewaldi* of Dunker.

"In previous notices of the fossils from this zone, by Mr. Strickland, the Rev. P. B. Brodie, and also by Dr. Wright, reference is made to a shell called *Pullastra arenicola*, Strickl., which is said to occur very abundantly, but only in casts, and of which no figure has been given; there is no doubt it belongs to the group under consideration. They have also been included by other English authors under the genera of *Tellinites, Isocardia, Cucullæa, Donax, Sedgwickia*, and *Schizodus*. It is not clear wherein the following shells from Beer-Crowcombe differ from the *Axinus* of Sowerby; and his name, having priority, is therefore retained."

We must recollect, however, that we have in this case a set of dwarfed shells, probably of brackish-water habitat.

[1] In a memoir in the 'Philosophical Transactions' for 1835, Dr. J. E. Gray treats of "shells having every appearance of belonging to the same natural genus, but inhabited by animals of a very different character" (p. 301); and, as examples, he enumerates—

Pupa and Vertigo.	Cytherea and Artemis.
Vitrina and Nanina.	Cyclas and Pisidium.
Rissoa and Truncatella.	Paludina and Littorina.
Siphonaria and Ancylus.	Littorina and Phasianella.
Littorina and Assiminia.	Neritina and Nerita.
Mytilus and Dreissena.	Bullia and Terebra.
Anodon and Iridina.	Aporrhais and Rostellaria.

and by this author and other crustaceologists the animals of *Estheria* and its allies, the *Limnadia* and *Limnetis*, had been already fully made known. Another important result of the application of the microscope to these once obscure organic remains was the determination of the intimate structure of the shell as belonging to crustacean and not to molluscan organisms. Whilst the shell of *Posidonomya Becheri* of the Lower Carboniferous rocks is truly of the molluscan type,[1] that of the so-called *Posidonomya minuta* and its allies is crustacean.

One of the fossil *Estheriæ* (*E. tenella*, passing under the name of *Posidonomya*) was regarded by Agassiz, in 1845, and by Naumann, in 1848, as being related to *Cypris*; Dr. Volger, in 1846, suggested of another (*E. minuta*) that it might be a bivalved Crustacean; and another (*E. ovata*) was suggestively referred to the *Cypris* and its allies by Lyell and Morris in 1847.

In 1856 the Rev. W. S. Symonds, F.G.S., favoured me with some well-preserved specimens of the little Triassic *Estheria*[2] from Pendock, Worcestershire; and with the late Prof. J. Quekett's kind assistance I was enabled to see most distinctly the true crustacean character of the tissue of its valves under the microscope. This confirmed an opinion I had long held, and which had been previously advanced by Agassiz and Naumann,[3] by Volger[4] and by Lyell and Morris,[5] that some of the little fossils known as *Posidonomyæ* are not molluscs, but closely allied to the *Limnadia, Limnetis*, and *Estheria*, bivalved phyllopodous Crustaceans (*Entomostraca*) of the present day; and, indeed, as far as the carapace-valves are concerned, this and the other so-called *Posidonomyæ* referred to correspond to the *Estheriæ* of Rüppell and Baird[6] (*Isaura*, Joly; *Cyzicus*, Audouin).

Different species of these fossil *Estheriæ* occur in the Devonian rocks (Caithness, Orkney, Livonia, and Russia); Carboniferous (Scotland, Northumberland, Lancashire, Derbyshire, Belgium, France, Bavaria, and Silesia); Permian (Ireland, Saxony, and Russia); Triassic (England, France, and Germany); Rhætic (Somerset, Gloucestershire, Warwickshire, Worcestershire, and Elgin); Oolitic (Skye and Scarborough); Purbeck (Dorset); and Wealden (Sussex and Hanover). Others are met with in the coal-fields of Lower Mesozoic age, in North Carolina and Virginia, and along their north-western extension, forming

[1] Having the late Professor Quekett's authority in deciding the molluscan character of a shell of the Lower Carboniferous *Posidonomya* from Northumberland, which we examined together under the microscope, I cannot agree with Mr. J. W. Salter in thinking it probable that the great *Posidonomyæ* of the Carboniferous rocks are crustacean, as suggested in his paper in the 'Annals Nat. Hist.,' 3d ser., 1860, vol. v, p. 153.

[2] This is the little Triassic shell that has been termed *Posidonia*, and *Posidonomya, minuta; Posidonia minuta* (Alberti), Goldfuss; *Posidonomya minuta*, Bronn, Zieten, Strickland, and others. In Morris's 'Catalogue of British Fossils,' 2nd edit., 1854, it is included in the *Crustacea* (as *Estheria minuta*); but (apparently from inadvertence) it has not been expunged from the list of molluscs in that work.

[3] 'Bullet. Soc. Géol. France,' 2nd ser., vol. v, p. 301, and vol. vi, p. 90.

[4] 'Neues Jahrbuch f. Min.' 1846, p. 818.

[5] 'Quart. Journ. Geol. Soc.,' vol. iii, p. 275, and Lyell's 'Manual of Geology,' 5th edit., p. 332.

[6] 'Proc. Zool. Soc.,' part 17, 1849, p. 87.

the so-called "New Red Sandstone" of Pennsylvania;[1] and in the plant-bearing sandstones of India (Mangali, Panchét, and Kotah); and in beds of undetermined age (probably Tertiary) in Siberia and South America.

Although occurring so constantly in the different geological periods, from the Devonian to the Wealden,[2] and again in some Tertiary beds and in the recent fresh waters, yet it is in the Rhætic and Triassic deposits of Britain and the Continent, and the sandstones and bituminous shales of Pennsylvania, Virginia, and Carolina, and in the plant-bearing beds of India, that this little Bivalved Entomostracan appears to be pre-eminently abundant, so as to serve probably as a faithful index of a peculiar geological horizon.[3]

In like manner, among the still lower forms of life, the Nummulite is represented in the Carboniferous, Liassic, Oolitic, and Cretaceous rocks, and exists also at the present day; but it particularly distinguished one epoch (the Tertiary) by a surprising fecundity and a temporary profusion of individuals.

The occurrence of a fossil *Estheria* in the Upper Sandstone and Shale of the Scarborough district (*E. concentrica*, Bean,[4] sp.) is of considerable interest, as indicative of the association of this crustacean genus with the Jurassic flora in England, as it is with a Jurassic-like flora in India and North America.

In India a Triassic Labyrinthodont reptile (*Brachiops laticeps*[5]) is found in the same strata as yield the *Estheria* at Mangali, possibly contemporaneous, or nearly so, with those containing plants at Nagpur; near Panchét also, in north-eastern India, *Estheria* occurs in equivalent beds, with Dicynodont and Labyrinthodont remains; and in Pennsylvania reptilian remains[6] occur with the so-called "Posidonomya;" in North America, indeed, the evidence seems to point to a contemporaneity of the coal- and plant-beds of Carolina and Virginia, the shales and sandstones of Pennsylvania and New Jersey, the foot-marked sandstones of Connecticut, and the Upper Red Sandstone of Nova Scotia and Prince Edward's Island, which is also reptiliferous;[7] and it is evident that in the Virginian and Pennsylvanian shales the minute crustaceans under notice are important fossils. The fossil plants of India and of Virginia and Carolina having a Jurassic facies, like those of the Venetian Alps and Scarborough, it will be interesting, as further evidences turn up, to see how far we are to regard the Triassic or the Jurassic element as preponderating, or

[1] Continuous with the sandstones of New Jersey, and most probably with those of Connecticut also.

[2] I have no satisfactory evidence of the presence of the genus in question in the Cretaceous deposits.

[3] Prof. W. B. Rogers has already pointed out ('Boston Nat. Hist. Soc. Proc.' v, p. 15, &c.) the probable value of this little fossil in the comparison of the Mesozoic rocks of North Carolina and Virginia, and of these with the so-called Triassic beds of the United States.

[4] 'Mag. Nat. Hist.,' vol. ix, p. 376.

[5] 'Quart. Journ. Geol. Soc.,' vol. ix, pp. 37 and 371.

[6] Lea on *Clepsysaurus Pennsylvanicus*, 'Journ. Acad. N. Sc. Philad.,' n. s., vol. ii, p. 185; and on *Centemodon sulcatus*, 'Proc. Acad. N. Sc. Philad.,' n. s., vol. viii, p. 377.

[7] Leidy on *Bathygnathus borealis*, 'Journ. Acad. N. Sc. Philad.,' n. s., vol. ii, p. 327.

whether a passage-group of deposits ("Rhætic") are indicated by the evidence; or, lastly, whether these Plant-beds with Reptiles and Crustaceans indicate the terrestrial and lacustrine conditions only of the early Mesozoic period.

The Jurassic-like flora of Australia[1] and that of southern Africa have been hitherto collected without affording any clear traces of the *Estheria*. The latter country, however, has its probably Triassic reptiles, the *Dicynodon* and its many associates, imbedded with this flora;[2] so that the peculiar association above indicated for India and North America obtains there also.

In pointing out these facts of the geological and geographical distribution of the fossil *Estheria*, I merely touch upon the salient points of an interesting subject of research, for the elucidation of which careful inquiry at home and abroad is still requisite.

The known species of living *Estheria* are—

ESTHERIA GIGAS, *Hermann*, sp. Baird, Proc. Zool. Soc., 1849, p. 87 (=*Cyzicus Bravaisii*, Audouin, Annal. Soc. Entom. vi, Bullet., p. IX, 1837; *Isaura cycladoides*, Joly, Annal. Science Nat., 2 sér., 1842, xvii, p. 293, pl. 7, 8, and 9 A (figs. 1—45); *Estheria cycladoides*, Lucas, Explor. Scientif. Algerie, Crustacés, 81, 1845.	Freshwater pools, Strasburg (*Hermann*); brackish water marsh, Arzeu, near Oran, Africa (*Bravais*); ditch filled with rain-water (in June), Toulouse (*Joly*); Tunis (*Frazer*); Algeria (*Lucas*).
— DAHALACENSIS, *Straus-Durckheim*. Mus. Senckenb., ii, p. 119, pl. 7, figs. 1—16; Baird, Proc. Zool. Soc., 1849, p. 89, Annulos. pl. 17, figs. 2—4.	Freshwater marshes of the Island of Dahalac, on the coast of Abyssinia, in December (*Rüppell*); and in stagnant water, on the banks of the Tigris, near Bagdad (*W. K. Loftus*).
— MELITENSIS, *Baird*. Proc. Zool. Soc., 1849, p. 88, Annulos. pl. 11, fig. 2.	Rain-water pool, Malta (*Hennah*); Sicily (*Cuming*).
— POLITA, *Baird*. Ib., fig. 3.	India (interior, N. E.), *Boys*.
— BRASILIENSIS, *Baird*. Ib., p. 89, pl. 11, fig. 4.	Brazil (*Sowerby*).
— DONACIFORMIS, *Baird*. Ib., fig. 5.	Abeyd (White Nile), Kordofan (*Parreyss*).
— BOYSII, *Baird*. Ib., fig. 6.	India (interior, N. E.), *Boys*.
— SIMILIS, *Baird*. Ib., fig. 7.	India (interior, N. E.), *Boys*.
— TETRACERA, *Krynicki*, sp. Bullet. Soc. Imp. Nat. Moscou, ii, 1830, p. 176, pl. 7, fig. 1; Baird, Proc. Zool. Soc., 1849, p. 90.	Freshwater marsh (in May), near Charkow, Russia, and at and near Moscow (*Krynicki, Fischer, and de Laveau*, 1817—29).
— DALLASII, *Baird*. Proc. Zool. Soc., 1852, p. 30, Annulos. pl. 23, fig. 5.	Brazil (?) *Dallas*.

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[1] See M'Coy's paper, 'Ann. and Mag. Nat. Hist.,' vol. xx, p. 145, &c.; and the Rev. W. B. Clarke's, 'Quart. Journ. Geol. Soc., vol. xvii, p. 354. Labyrinthodont reptiles have not been wanting in Australia; see Professor Huxley's paper on the *Bothriceps Australis*, 'Quart. Journ. Geol. Soc.,' vol xv, p. 647.

[2] Glossopteris, &c.; 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 329. Dicynodont remains have also been discovered lately in connection with the coal-bearing strata of Bengal (ibid., p. 362, and Mem. Geol. Surv. India, vol. iii, part 1.)

Estheria Hislopi, *Baird.* Proc. Zool. Soc., 1859, p. 232, pl. 63, fig. 1.	Freshwater stream, near Nagpur, central India (*Hislop*).
— compressa, *Baird.* Proc. Zool. Soc., 1860, p. 188, pl. 71, fig. 6.	Freshwater pools, Nagpur (*Hislop*).
— Birchii, *Baird.* Ibid., p. 392, pl. 72, fig. 1.	Pools of freshwater, on the banks of the Wamoi River, Australia (*Birch*).
— Gihoni, *Baird.* Ann. Mag. Nat. Hist., 3rd ser., vol. iv, 1859, p. 281, pl. 5, fig. 1.	Freshwater pool of Gihon, Jerusalem. *E. Gihoni* was reared in England, by Mr. H. Denny and Dr. Baird, from the dry mud brought from the Pool of Gihon.
— Hierosolymitana, *Fischer.* Abhandl. k. bayer. Akad. Wiss. München., viii, 1860, p. 649, pl. 20, figs. 7, 8.	Rain-water pools on limestone, near Jerusalem, dry for ten or eleven months in the year (*J. R. Roth*).
— Australis, *Lovén.* Öfvers. af K. Vet. Ak. Förh., Årg. 3, 1846 (Stockholm, 1847), p. 57.	Freshwater marshes, Natal (*J. Wahlberg*).
— Dunkeri, *Baird,* MS.	Zimapan, in the neighbourhood of Mexico, where it lives with *Planorbis nitens,* Ph., *Limnæus subulatus,* De Kr., *Physæ,* and other molluscs, in stagnant waters (*Dunker,* Nordd. Wealdenbild., 1846, p. 61).
— Jonesi, *Baird,* MS.	Brackish water, Cuba (through *Dr. Dunker*).
— Loftusi, *Baird,* MS.	Stagnant water, on the banks of the Tigris, near Bagdad (*W. K. Loftus*).
— Caldwelli, *Baird,* MS.	Lake Winnipeg (*W. Caldwell*).
— Rubidgei, *Baird,* MS.	From the bed of a dried-up "vley" near Port Elizabeth, South Africa (*R. N. Rubidge*).
— Macgillivrayi, *Baird,* MS.	Brackish lake at Green Point, Cape of Good Hope (*J. McGillivray*).

The closely allied genera *Limnadia* and *Limnetis* are known by the following species:

Limnadia Hermanni, *Ad. Brogn.* Baird, Proceed. Zool. Soc., 1849, p. 86, Annulos. pl. 11, fig. 1.	Freshwater pool, Fontainebleau (*Brongniart*).
— Mauritiana, *F. E. Guérin.* Magas. de Zool., Sept. Année, Class VII. p. 1—7, pl. 22 (21 in the text) figs. 1—11, 1837; Baird, Proc. Zool. Soc., 1849, p. 87.	Mauritius (*Julien Desjardins*).
— Antillarum, *Baird.* Proc. Zool. Soc., 1852, p. 30, Annulos. pl. 23, fig. 1.	San Domingo (*Sallé*).
— coriacea, *Haldemann.* Proc. Philad. Acad., 1842, vol. i, p. 184; and 1854, vol. vii, p. 34.	"In ditches along the Susquehanna, in quiet water;" in "roadside ditches" (*S. S. Haldemann*). In fresh water, Cincinnati (*T. Kite*).
Limnadella Kitei, *Girard.* Ibid., 1854, vol. vii, p. 3.	
Limnetis brachyurus, *Müller.* Entomost., p. 69, t. 8, figs. 1—12.	Freshwater marshes, Denmark (*Müller*).

Limnetis Wahlbergii, *Lovén.* Öfvers. k. Vet. Akad. Förh., Årg. 3, No. 2, p. 57, 1847.	Freshwater marshes, Natal (*J. Wahlberg*).
— Gouldii, *Baird.*	Fresh water, at St. Ann's, twenty miles from Montreal (*C. Gould*).[1]

The recent *Estheriæ* are found in fresh water, rarely in brackish water. Guided by this fact, and taking for granted that our fossils were true *Estheriæ*, and that *Estheriæ* always have had freshwater habitats, we should suppose that the deposits in which these fossils are found, free from any appearance of having been drifted, must have been formed in rivers, lakes, or lagoons. Applying, however, the same rules in judging of the nature of the fossil molluscs and other organic remains that occasionally accompany some of these *Estheriæ*, we must regard the *Lingula* of the Old Red (of Livonia), the *Spirorbis*, the *Aviculæ*, the *Anthracosiæ*, and *Anthracomyæ*[2] of the Carboniferous shales, and the *Lingula* and *Pleurophorus* of the Trias, as truly marine shells. Many, however, of our fossil *Estheriæ* occur in strata destitute of any such evidence of marine conditions; and possibly the occasional mixture of the marine and freshwater organisms may have been the result of driftage (the free-swimming *Estheriæ* being readily swept away by a flood), or of very rapid changes of condition, such as might be brought about by the alternate occupation of a lagoon by sea- and river-water.[3] Seeing, too, that the recent *Estheriæ* appear, as it were, suddenly (like the *Apus*) in pools and ditches of rain-water, and are quickly developed in tanks and ponds dry for even ten or eleven months in the year, it is not unlikely that pools of fresh water, temporarily formed on a flat seashore, may have been inhabited by *Estheriæ*, destined to be quickly buried in the first wind-drift of sand, or at the return of high tides. As an inhabitant of brackish water, the *Estheriæ* would be still more likely to have been occasionally accompanied by marine shells: nor can we say that the fossil associates quoted above were not inhabitants of brackish water, or of salt lakes; for experience is the only guide to the naturalist in determining whether the members of many of the molluscan groups affect marine, brackish, or freshwater habitats.

Perhaps some might like to think that at first marine conditions alone suited aquicolous animals, and that some have subsequently taken to brackish and freshwater habitats; and this may have been the case with *Estheria:* but, except for the "progressive" aspect of the argument, the converse might just as well hold good for the *Lingula*,[4] *Spirorbis*, *Avicula*, *Anthracosia*, *Anthracomya*, and *Pleurophorus*, mentioned as being found in the older rocks in company with *Estheria*.

Of the living molluscan genera that are known to have fluvicolous as well as marine

[1] Dr. Baird has kindly assisted me in drawing up this table of the recent *Estheriæ* and their allies.

[2] According to Mr. Salter, 'Mem. Geol. Survey, 1861, Iron-ores of South Wales,' &c.

[3] See Sir C. Lyell's observations on the value of *Spirorbis* (in the fossil state), and barnacles (recent) in certain cases, as evidences of the occasional inroad of salt water into swamps, killing the marsh-plants and leaving behind such shells as the above, as well as *Modiolæ*, &c. ('Notices of the Royal Institution of Great Britain,' vol. i, p. 285.)

[4] See further on, for remarks on the *Lingula tenuissima* of the Trias.

species, the following are the most prominent:—*Rissoa* (*Assiminia*), *Cerithium* (*Potamides*), *Arca* (*Scaphula*), *Solecurtus* (*Novaculina*), *Mytilus* (*Dreissena*), and *Cardium*,[1] but how the extinct genera were circumstanced in this respect, and whether the old species of extant genera had similar habitats to those of their existing congeners, can only be partially surmized, chiefly from the evidence of the best known of their associates.

There are some existing genera the species of which appear to be essentially fluviatile, but live also in company with true marine shells in the mouths of rivers; these are *Cyrena* and *Ampullaria*. Such, too, may have been the habit of the old *Estheriæ;* at all events, there is no necessity for supposing them to have been marine; but where they occur by themselves, or in the company only of fishes[2] and plants,[3] they may be regarded as having lived and died in fresh (or possibly brackish) water; where they are mixed with shells of presumed marine character, they indicate probably that fresh water was in close proximity to the place of deposit, if it had not been replaced by the sea by possibly frequent alternations.

We must not forget, however, that, judging by analogy, the Entomostracous Crustaceans under notice may have been capable of living, at least for considerable periods, in even salt water, for some of the common *Cyprides*, such as are abundant in freshwater streams, are not uncommon in ditches of brackish and even highly saline water in the low grounds near the sea.

[1] In Dr. J. E. Gray's "Memoir on Testaceous Mulluscs," in the 'Philos. Transact.' for 1835, he treats of "Species of Testaceous Mollusca living in very different situations from the majority of the known species of the genus to which they belong, or having the faculty of maintaining their existence in several different situations;" and he illustrates the case (1st) of species of the same genus being found in more than one situation, as on land, and in fresh and in salt water, by *Auricula* (including *Conovulus* and *Chilina*); (2nd) of one or more species of a genus most of whose species inhabit fresh water being found in salt or brackish water, by *Limnæa, Neritina, Melania,* and *Melanopsis;* (3rd) of one or more species of a genus whose species usually inhabit the sea being found in fresh or brackish water, by—

Aplysia,	*Mya,*
Cerithium,	*Corbula,*
Bulla,	*Ostrea* (?)
Littorina (*Lithoglyphus*),	*Cucullæa* (*Scapula*),
Solen (*Novaculina*),	*Neritina* (*Theodoxus*),
Tellina,	*Ampullaria* (?), and
Avicula,	*Cardium.*

M. Beudant found by experiment (1803—1816), that many freshwater molluscs can be made by degrees to live in water gradually salted to the ordinary saltness of the sea; and that many marine molluscs can also, by gradually diminishing the saltness of the water, be accustomed to live in fresh water. See 'Comptes Rendus,' May 13th, 1816; 'Annales des Mines,' 1816, vol. i, p. 397, and De la Beche's 'Selection of Geological Memoirs,' 1824, p. 36.

[2] With some exceptions, it is impossible to say of any fossil fish that it did, or that it did not, belong exclusively to the sea, even when it is occasionally associated with marine fossils, as some of the Old Red fishes are in Russia. Many genera of fishes are as capricious, as to the habitats of their species, as the above-quoted molluscs are. Nor must we forget that the stony-scaled and plated fishes of Palæozoic times are now best represented by the Bichirs and the Sheat-fishes of existing rivers (Huxley; 'Mem. Geol. Surv.,' 1861).

[3] The association of remains of land-plants with the *Estheriæ* is of frequent occurrence.

The following Table shows the distribution of the fossil *Estheriæ* and *Leaiæ*[1] described in this Monograph, and the organic remains found in association with them :—

Genus and Species.	Locality.	Geological Stage.	Associated Organic Remains.
Esth. membranacea, *Pacht*, sp.	Livonia	Old Red	Lingula. Fishes.
,, ,,	Caithness	Old Red	Fishes.
E. striata, *Münster*, sp.	Bavaria	Lower Carboniferous	
,, ,,	Belgium	Lower Carboniferous	
,, ,, var. Tateana	Berwickshire	Lower Carboniferous	Spirorbis. Fish. Plants. Cypridæ.
,, ,, ,, Beinertiana	Silesia	Lower Coal-measures	
,, ,, ,, ,,	Lancashire	Lower Coal-measures	Spirorbis. Cypridæ.
,, ,, ,, ,,	Lanarkshire	Lower Coal-measures	
,, ,, ,, Binneyana	Derbyshire	Lower Coal-measures	
,, ,, ,, Beinertiana	Lancashire	Middle Coal-measures	Fishes.
Leaia Leidyi, *Lea*, sp.	Pennsylvania	Lower Carboniferous	Plants.
,, ,, var. Salteriana	Fifeshire	Lower Carboniferous	
,, ,, ,, Williamsoniana	Lancashire	Upper Coal-measures	Anthracosia.* Plants.*
Estheria tenella, *Jordan*, sp.	France (Autun)	Upper Coal-measures	Fishes * and Plants.*
,, ,,	Schwarzwald	Upper Coal-measures	Crustaceans* (*Gampsonyx*).
,, ,,	Lancashire	Upper Coal-measures	Beyrichia.
,, ,,	Lanarkshire	Upper Coal-measures	Spirorbis. Anthracosia. Avicula.
,, ,,	Saxony	Lower Permian	Fishes and Plants.
E. exigua, *Eichwald*, sp.	Russia	Permian	Beyrichia. Plants.*
E. Portlockii, sp. n.	Ireland	Permian	Fishes.*
E. minuta, *Alberti*, sp.	France	Bunter	Limulites.* Apus. Plants *
,, ,,	Hanover	Bunter	
,, ,,	Germany	Lettenkohle	Lingula. Pleurophorus. Lignite.
,, ,,	Hanover	Keuper	
,, ,,	Worcestershire	Keuper	Fishes* and Plants.*
,, ,,	Warwickshire	Keuper	Fishes.*
,, ,,	Somersetshire	Keuper	
,, ,, var. Brodieana	Gloucestershire	Rhætic	Plants.
,, ,, ,, ,,	Somersetshire	Rhætic	Cardium (?). Plants. Insects.
,, ,, ,, ,,	Morayshire	Rhætic	Cypridæ. Reptiles.* Fishes.* Plants.*
E. Mangaliensis, sp. n.	India	Triassic or Rhætic	Reptiles.* Fishes.* Plants.
E. Kotahensis, sp. n.	India	Rhætic or Jurassic	Cypridæ. Fishes.* Plants. Insects.
E. ovata, *Lea*, sp.	North America	Triassic or Rhætic	Cypridæ. Fishes.* Plants.* Reptiles.
E. Murchisoniæ, sp. n.	Skye	Oolite	
E. concentrica, *Bean*, sp.	Yorkshire	Oolite	Plants (Ferns and Cycads).
E. elliptica, *Dunker*	Germany	Wealden	Cyrena. Cypridæ. Plants.*
,, ,, var. subquadrata	Sussex	Wealden	Cyrena. Cypridæ. Plants.*
E. Forbesii, sp. n.	South America	Mesozoic?	Ferns or Cycads.
E. Middendorfii, sp. n.	Siberia	Tertiary?	Fishes (*Aspius*). *Paludina* (?). Plants. Insects.

Marked thus * not in the same seam, but in closely associated beds.

[1] *Leaia* is a problematical ally of *Estheria*. See the Appendix.

Dr. S. Fischer assigns a shorter carapace to the female of his *E. Hierosolymitana*[1] than the one belonging to the male. The squarer carapaces above referred to are rare among the subovate individuals: some of the latter certainly bear what appear to be ova.

Of *Isaura cycladoides* (*Estheria gigas*) M. Joly has remarked that in its young state it undergoes certain successive changes of form, more or less analogous to the persistent conditions of "*Artemia, Branchipus, Apus, Daphnia, Lynceus, Cypris, Limnadia,* and *Cyzicus;*" one of these stages being marked by the presence of a horizontal Apus-like carapace, and others being accompanied by varied outlines of the carapace-valves. These observations should make us very careful in the examination of the different forms of carapaces, especially those found associated in the same set of strata, and prepare us for the possible specific identity of dissimilar carapaces.

Recent *Estheriæ* have sometimes so thin a carapace that the valves curl up when dry, like horn-shavings or flakes of quill. In other cases, however, the valves are stout enough to retain their convex oviform or Cycladiform shape when dry. Fossil *Estheriæ* also have varied in this respect. We sometimes find in them more variety of ornamentation on one and the same valve than has been observed in single recent specimens. Possibly, however, a closer examination of some of the recent valves might show similar series of modified sculpture on individual specimens.

About twenty species of *Estheria* are known to occur in the recent state, and six or seven of the two allied genera *Limnadia* and *Limnetis.* (See page 5.) These are distinguished respectively either by differences in the form and ornament of the carapace, or by more or less important modifications of the limbs or other organs. Our characterisation of the fossil *Estheriæ* must necessarily be independent of the structural differences in the body itself; and it is therefore possible that the limited number of species indicated as fossil, and distributed by one and two through the several great accepted geological formations, might be somewhat enlarged if we set a high value on every recognisable difference in the outline and ornamentation of the valves. I have been careful, on the contrary, to restrict myself as far as possible in setting much value on slight modifications in the fossil *Estheriæ.*

When the umbo of the carapace-valve is near the anterior end, as is most frequently the case, we have a resemblance to some of the subtriangular and subovate Bivalve Molluscs, such as *Pisidium, Tellina,* &c.; when the umbo is more nearly central, there is sometimes a resemblance to *Avicula* or *Posidonomya;* and this likeness may be strengthened by the valves of the little *Estheria* being often wrinkled concentrically, the sharp ridges and neat interspaces being replaced by numerous convex ridges, and nearly all the original structure lost. Still a trace of the peculiar reticulate ornamentation is usually left; and the superinduced wrinkles are not so evenly convex as is usual in the *Aviculidæ,* nor so uniformly marked with parallel concentric striæ as is frequently the case with those shells (see Pl. I, figs. 31, 32, *Inoceramus Suessii,* Oppel). The valves are rarely so

[1] 'Abhandl. Akad. Wiss. München,' viii, p. 649, pl. 20, fig. 8.

quadrate as in the *Posidonomya* and *Inoceramus;* and neither the wrinkles nor the ridges (whichever may mark the valves of the *Estheria*) are bent off away from the umbo to follow the outline of the produced ears of the shell present in most of the *Aviculida*, but absent in *Estheriæ*. Nor is there any trace of furrows or teeth on the hinge in *Estheria*.

A general crumpling of the shell of a very thin *Avicula* or *Posidonomya* irregularly corrugates the whole surface, concentric wrinkles and all; but in *Estheriæ* the true ridges are seldom thus interfered with, but rather yield to the transverse pressure by taking on an obliquity of direction, leaving the sculptured interspaces to show the crumpling effect of pressure. Rarely converted into calcareous matter, the Estherian carapaces usually present a delicate, brownish, horn-like tissue, generally with some degree of transparency and polish, contrasting with the dull perfectly calcified shells of the *Aviculidæ*, or their bold wide-ridged impressions, black and filmy, or delicately nacreous. In carbonaceous deposits the *Estheriæ* often leave only black films or merely impressions. In one case a white siliceous (?) substance is found to replace the valves in a brown-coal. Sometimes a ferruginous film has replaced the carapace-valves, especially in sandstone.

As the *Estheria minuta* has been referred to *Posidonomya* so generally and for so long a time, it is highly probable that other little fossils of the same class still pass as *Aviculidæ* in palæontographical works and collections. That attention might be turned to these, I would point out some figured specimens which appear worthy of special microscopical examination. The small shells figured by Pusch ('Polen's Palæontolog.,'pl. 5, fig. 14) as the young of *Catillus Brongniarti* have a strong resemblance to *Estheria*, and are the more worthy of examination as they are said to come from the clay-beds above the Jurassic limestone. Figs. 11 and 12 of pl. 37 of Reuss's 'Kreideform. Böhm.' are not so promising; they may really belong to *Inoceramus Crispii* and *I. planus*, to which they are referred. Some of the fossils figured in pl. 17 of Lynch's 'Report on the Geology of the Dead Sea' might possibly be worth re-examination; also the Australian fossil figured in 'Annals Nat. Hist.' vol. xx, pl. 13, fig. 3. The *Posidonomya Wengensis*, Wissman, and *Avicula globulus*, Wissm. 'Münster's Beiträge,' iv, p. 23, pl. 16, figs. 12 and 13, from the St. Cassian beds of the Tyrol, should certainly be looked at by a crustaceologist. *Cardinia nana*, de Koninck, 'Anim. foss. Terr. Carb. Belg.' p. 71, pl. 1, fig. 6, is another little shell to be examined. In the 'Geognostische Skizze der Umgegend von Ilmenau am Thüringen Walde' (Zeitschr. deutsch. geol. Gesell. xii, 1860), Herr Karl von Fritsch remarks (p. 144), "Near Goldlauter, not far from Ilmenau, some beds are nearly full of *C. nana*. These flattened shells remind one of the Triassic *Posidonomya minuta*, Bronn. Perhaps it is the same shell as von Gutbier mentions in his 'Versteinerung. des Rothliegendes in Sachsen,' p. 7."

1. ESTHERIA MEMBRANACEA, *Pacht,* sp. Pl. I, figs. 1—7.

POSIDONOMYA, *d'Eichwald.* Geology of Russia, (published in the Russian language), 1846, p. 399.
ASMUSIA MEMBRANACEA, *Pacht.* Der Devonische Kalk in Livland, 1849, p. 44.
POSIDONOMYA MEMBRANACEA, *Pacht.* Ueber Dimerocrinites oligoptilus, 1852, p. 26; and Der Devon. Kalk. Livland, 2nd edit., 1859, p. 44, fig. 7.
— RUGOSA, *Kutorga.* Geognostische Karte des Gouvernements von Petersburg, 1852.
ESTHERIA, *Rupert Jones.* Quart. Journ. Geol. Soc., 1855, vol. xii, p. 376.
? POSIDONIA RUGOSA (*Kutorga*). *Von Helmersen.* Geognostisch. Untersuch. mittl. Gouv. Russlands, 1858, p. 73.
ESTHERIA MURCHISONIANA, *Rupert Jones.* Quart. Journ. Geol. Soc., 1859, vol. xv, p. 404, woodcuts, fig. 14, *c*, *d* (p. 408).
ASMUSIA MEMBRANACEA (*Pacht.*), *Pander.* Monographie ueber die Saurodipterinen, &c., 1860, p. IV.

Height of valve, about $\frac{1}{8}$ inch } Proportion 9 to 11, or 1 : 1 +
Length, nearly .... $\frac{1}{6}$,,

This species occurs both in Scotland (Caithness) and in Russia (Livonia and elsewhere).

I shall describe the Scottish specimens first:—

Valves subquadrate, occasionally somewhat oblong in form, the majority being about 1-6th inch long and 1-8th inch high, whilst some are as high as long. Pressure, however, has interfered with the contours and proportions of many of these valves. The hinge-line is straight; the generality of the valves have the anterior and posterior edges forming sharp angles with the dorsal line and passing vertically with a slightly convex outline to the boldly rounded ventral border. In this case the umbo is distinct; almost, but not quite, in the middle of the dorsal line; and bordered by a triangular depressed, but not produced, ear on either side; the valve resembling somewhat that of a miniature *Posidonomya,* or upper valve of an *Aviculo-pecten.*

The surface is wrinkled, by about 18 to 20 concentric, rounded, closely set wrinkles, uniform with the outline of the ventral border and extremities of the valve. The wrinkles are coarsest near the umbo, their starting point, and they become finer as they approach the edges of the valve.

Under the microscope, between the broad wrinkles are seen, here and there, thin sharp ridges lying in the narrow furrows; and the patches of the outer surface, here and there retained, are seen to be of a dark-brown opaque substance, exhibiting on and between the

wrinkles a finely granular appearance, which is probably due to the modification of an originally minute reticulate ornament, by the pressure of the sand-granules of the matrix (fig. 5). Some layers of the valve, when exposed by flaking, are quite smooth, amber-coloured, and semi-transparent. The differences between the conditions here described and those observed in the better preserved specimens from Livonia will be pointed out when the latter specimens come to be described presently.

As it is possible that the difference in shape between the many subquadrate and the few oblong valves may be due to pressure, to a condition of growth, or perhaps to difference of sex, it would be too hazardous even to distinguish them by name as varietal forms.[1] Indeed, circumstances have so modified the great majority of the valves in the slabs of stone, on the bedding-planes of which they occur, that the whole outline of a valve can very rarely be definitely traced even among a hundred individuals; for the edges either overlap, are squeezed out of proportion, are broken away, or, lastly, remain buried a little way in the matrix.

The carapace-valves of this small bivalve Crustacean occur plentifully on some of the surface-planes of the Caithness Flagstones, near Wick, and also in the Orkney and Shetland Isles, and have been noticed by Hugh Miller and others.[2] Their close resemblance to the shells of small bivalve molluscs formerly led to their being taken for the shells of *Astarte, Venus, Cyclas,* &c.; but their supposed relation to molluscs having been doubted,[3] some specimens from near Thurso, collected by Mr. Peach, were given to me by Mr. Woodward, in 1855; and a far larger number, and better preserved, from Kirkwall and Murkle Bay (collected by Mr. Dick), were confided to me for examination by Sir R. Murchison in 1858.

In their substance, consistence, configuration, and size, these little valves offer direct analogies to the bivalved carapaces of certain recent Phyllopodous Crustaceans (*Estheriæ*) inhabiting the rivers and lagoons of hot countries, and often much resembling the shells of *Nucula, Cyrena,* &c.

Great numbers of the valves are spread over large surfaces of the flagstone, sometimes scattered sparsely, sometimes congregated in groups, forming films between the layers of the fissile stone. The valves are usually single; pairs, with their hinge-lines in juxtaposition, are rare. The specimens which I have are in dark-grey, tough, fine-grained, sandy

[1] In one or two instances I have been almost misled by apparently elongate valves, which are in truth, two valves pressed accidentally one on another "conformably," but still one extending a little beyond the other.

[2] Miller's 'Old Red Sandstone,' 1st edit., 1841, p. 99, pl. 5, fig. 7; 4th edit., 1850, p. 132, pl. 5, fig. 7; edit. 1858, p. 116; 'Cruise of the Betsey,' 1858, p. 415. Dr. J. G. Malcolmson, 'On the Relations of the Old Red Sandstone,' &c. (read in 1839), 'Quart. Journ. Geol. Soc.,' vol. xv. (1859), p. 351; Sir R. I. Murchison, Ibid., p. 404, 411, and 413; 'Siluria,' 2nd edit., 1859, p. 288; C. W. Peach, 'Trans. R. Geol. Soc. Cornwall,' 1855, p. 232.

[3] By Mr. S. P. Woodward, at the Meeting of the British Association at Liverpool, 1854.

flagstone, slightly micaceous, somewhat varying in tint and hardness. They usually appear to have a superficial smoothness or even gloss, and often a light-brown tint, with some degree of translucency. But the substance of the valve flakes off readily, leaving a film on each of the two surface-planes in a split stone; and it is comparatively seldom that a valve shows its real exterior; for, though the surface may sometimes come away from the stone in splitting, and leave a clean cast, yet an outer flake of the valve seems nearly always to have fallen away with the shock of the blow; and the sandy nature of the matrix is too coarse to retain traces of any very fine microscopic sculpturing in the cast or mould of the surface. Something like a regular sculpturing appears on some specimens, as we see in fig. 5; but this is too much interfered with by the pressure of the sand-grains to be taken for the true ornament.

In the Kirkwall specimen the valves are pyritized; but those from Caithness retain their brown horny tissue, although the outermost surface is seldom preserved, and only in little patches on some valves. From this circumstance it is very difficult to form a correct diagnosis of the species; for the superficial ornamentation yields important specific characters in this genus, and in this case it cannot be satisfactorily studied.

Mr. C. W. Peach, of Wick, has favoured me, at my request, with the following notes on the geological distribution of the ESTHERIA MEMBRANACEA:—

"The first place where they were discovered was Pickoquoy Quarry, near the Peerie (Little) Sea, at Kirkwall. I have got them there *in situ*. They are found in a thin bed,[1] and lie in great quantities on the surface-planes, never to any depth, but just, as it were, interleaved. Here, as well as at all the other localities, they are accompanied by scales of fish and pieces of bone (of *Dipterus*, &c.).

"They occur also at Marwick Head, near Skaill, Orkney; and were found there first by Mr. W. Watt. In 1857, I found them in a new locality in Orkney, at the farm of Chumley, between the manse of Sandwick and Stromness, in a small quarry opened to build the farm-house and buildings there. The matrix is coarse, rather soft, and pale-blue, but makes good building-stone. They were rare, and were accompanied with a few fish-scales, probably of *Dipterus*.

"At Thurso East, Mr. Dick has got them near the castle-residence of Sir George Sinclair, Bart. I have also seen them *in situ* there, but few fell to my lot. I saw portions of fish remains near them. Mr. Dick has also got them in great quantities at Murkle Bay, between Thurso and Castle Hill.

"At Castle Hill, under the house of Mr. Traill, M.P., they are very abundant (first found by Dr. Sutherland), in a good building-stone, of a similar colour to that of Thurso and Chumley—pale-blue, and soft to the touch; as also at Kirkwall, &c. At Castle Hill they are not in thick layers, but interleaved, and occur with Fish-remains and Coprolites, lying amongst and on them. Near this place, about 10 feet above the Estheria-beds, are

[1] Scarcely half an inch in thickness, according to Hugh Miller; see his description of the quarry, in 'The Cruise of the Betsey,' 1858, p. 415.

beds of limestone, varying from 2 to 6 or 8 inches in thickness. These are composed almost entirely of fragments of bones and scales of fishes (some 2 inches in length, others smaller), cemented together by carbonate of lime, which, when pieces of the rock are steeped in dilute acid, is dissolved out, leaving the fish-remains standing in relief.

"A small greenstone-dyke passes through the Estheria-beds; and not far distant the rocks have been disturbed, and a great bed of bituminous shale occurs, which burns with a bright white flame, and smells like fish-oil. The greenstone-dyke is not above 2 feet wide; it does not appear to have disturbed the strata. I have found other such dykes since, near John O'Groat's and the Island of Stroma; and I find that these must have broken through after the flag-beds had become consolidated, because in the two latter places portions of the flagstones are enclosed in a breccia-like state in the trappean matter.

"Near Wick, I have met with limestones similar to those above mentioned, enclosing fish-remains, which, however, are much smaller than those in the limestone of Castle Hill. Some are very minute, and, where the rock has been exposed to the weather, show thin fine lines of yellow in the broken edges. All these beds take that colour wherever exposed, although they are bluish or dark grey when first broken. If put into acid, they soon become yellow. I believe that I have the *Estheria* also with these broken fish-remains at Wick. Some of these thin beds of broken fish lie nearer the Estheria-beds at Castle Hill than the thick beds which I mentioned.

"All the Estheria-beds that I know are amongst the flag-beds of commerce; consequently, according to Sir R. Murchison's 'Siluria' (pp. 283, 432, &c.), they are in the middle formation of the Old Red Sandstone.

"Sir R. Murchison mentions them as being found in Shetland. A little shell-like fossil that I got on Sumburgh Head was much like one." [C. W. PEACH, January 28, 1861.]

Mr. John Miller, F.G.S., of Thurso, has also supplied me with information respecting the local occurrence of these little fossils. He says—

"The *Estheria membranacea* was discovered by Mr. Robertson, of Inverugie (Elgin), in a quarry at the Peerie Sea, near Kirkwall, on the mainland of Orkney. The Orkney Islands are a prolongation of the Old Red Sandstone of Caithness, possessing a well-marked development of the triple arrangement characterising the Old Red series of the north-east corner of Scotland, as shown by Sedgwick and Murchison more than thirty years ago, and since confirmed by Sir R. Murchison in his various memoirs on the subject. The *Estheria* occurs in the middle member of the series, or the great fish-bed. Hugh Miller figured it as a molluscan shell in his well-known work, the 'Old Red Sandstone;' and shortly after that book was published Mr. Dick found the *Estheria* in Caithness, at various localities between Thurso and Murkle Bay, in the cliffs and shelving rocks of the sea-coast. I afterwards found it in the Brownhill Quarry, a little to the south-west of Thurso; and Mr. Peach has since found it at Castle Hill. From this last locality to Thurso

is about six miles. In Caithness, as in Orkney, it is only found in the middle member of the Old Red Sandstone, associated with *Asterolepis, Coccosteus, Dipterus, Diplopterus,* and *Osteolepis.*

"Of the vertical range of the *Estheriæ* it is difficult to speak, as all the localities in Caithness, alluded to above, are high up in the middle member of the Old Red series: if, however, quarries were opened lower down in this middle group, I venture to anticipate that the *Estheriæ* would still be found, as the same mineral conditions (calcareo-argillaceous flagstones, intercalated with sandstones,) persist almost from the top to the bottom of that group in Caithness, accompanied by the same characteristic fauna of Fishes, their scales being diffused throughout the strata in great abundance; and, as the *Estheriæ* have often been mistaken for the scales of *Dipterus,* I think it probable that many of those supposed scales may turn out to be the carapace-valves of the little Crustacean under notice." [J. Miller, February 4, 1861.]

The specimens of flagstone, bearing *Estheria membranacea,* that I have seen are as follow:—1. A black, micaceous, fine-grained flagstone, having a grey streak, and weathering olive-grey; the Estherian valves numerous, pyritous, iridescent under the microscope, and retaining no trace of the surface-ornament; accompanied with a coprolite-looking body. 2. From Thurso East, a greenish-grey micaceous flagstone, slightly calcareous; the valves numerous, preserving their tissue, but crumpled and broken. 3. From Murkle Bay, greenish-grey, micaceous, calcareo-argillaceous flagstone; the valves numerous, retaining here and there portions of their surface. As Hugh Miller has already observed,[1] the valves do not for the most part lie thinly and evenly scattered over the bedding planes of these hard laminated mudstones, but are clustered here and there in thickly set groups.

The valves occasionally retain their substance, and are then brown, opaque, and rugose; usually, however, a thin, smooth, shining, light-brown, horn-like film is all that remains.

Though the majority of existing and fossil *Estheriæ* have more or less oviform carapaces, with the umbo situated at or near the antero-dorsal angle, yet the position of the umbo at or near the centre of the dorsal line (as in *E. membranacea*) is not foreign to this genus; for *E. Hislopi,* Baird ('Zool. Proceed,' 1859, p. 232, Annulosa, pl. 63, fig. 1), from India has this condition; and *E. concentrica,* Bean, sp. (Pl. III, figs. 13—17) may be said to stand in the same category.

In July, 1859, Mr. J. W. Salter showed me some specimens (from Russia) of light-grey, very finely grained arenaceous clay, containing an *Estheria* apparently identical with *E. membranacea,* labelled "*Asmusia membranacea,* R. Pacht; with traces of *Lingula bicarinata,*[2] Kutorga; Kokenhusen." Dr. Pander has also favoured me with some specimens from Kokenhusen. These are identical with the *Estheriæ* from Caithness.

[1] 'Cruise of the Betsy,' p. 415.

[2] *Lingula bicarinata* is figured and described by Kutorga, in his 'Beiträge zur Geognosie und

The Livonian specimens are well preserved in their impalpably fine-grained matrix; they are much flattened, of a dull honey-colour, and beautifully neat in their graceful outline and their delicate concentric ridges (Pl. I, fig. 6). Like the Caithness specimens (Pl. I, figs. 1—4), they are almost symmetrically semicircular on the front, ventral, and hinder borders, and straight along the whole dorsal line, except where the umbo slightly protrudes somewhat in front of the centre. The outline is somewhat quadrate, with a slight obliquity, due to the eccentric umbo being the starting point of the conforming concentric ridges. The fulness of the curves of the ridges and of the ventral border are somewhat hindwards; the ridges being closer together on the anterior than on the posterior portion of the valve.

The well-preserved condition of the carapace-valves enables us to recognise about thirteen concentric ridges; and in some specimens a few fainter intermediate striæ are seen under the microscope. The coarse rounded wrinkles of the specimens in the Caithness sandy flagstones are the rough modifications of this delicate structure; either the ridges being squeezed up and distorted, or, in some cases, the intermediate hollows having been swollen up by the wrinkling pressure of the sandy matrix (figs. 2, 3, and woodcut, p. 22).

In the Livonian specimens, the interspaces between the ridges appear to be delicately sculptured with faint transverse wrinkles (fig. 7). This is in strong contrast to the coarsely granular appearance of the Caithness specimens (fig. 5), which have probably been impressed with the sand-grains of the matrix.

Asmusia membranacea, Pacht, is mentioned by Dr. Ch. Pander in his memoir 'Ueber die Saurodipterinen, Dendrodonten, Glyptolepiden, und Cheirolepiden des devonischen Systems' (St. Petersburg, 1860, p. IV), as being found in a greyish, laminated, calcareous marl, with intercalated grey and bluish clays, both full of Devonian fish-remains, on the River Torgel, in Livonia; but I was not aware that it had been figured and described until I received Dr. Ch. Pander's communication in November, 1861. (See p. 21). Of Kokenhusen, the locality above mentioned for *A. membranacea*, we have the following particulars in the 'Geology of Russia,' &c., by Murchison, De Verneuil, and Von Keyserling (p. 51):

"The picturesque rocks in the environs of the Castle of Kokenhusen [in Livonia] particularly deserve notice, not merely on account of the thickness of the vertical section[1] (speaking, of course, by comparison), but specially because the beds contain Ichthyolites.

Palæontologie Dorpats,' &c., 1835—37 ('Verhandl. d. min. Gesellsch. zu St. Petersburg,' 1846, p. 110, pl. 7, fig. 12); and is also described in Eichwald's 'Lethæa Rossica,' livr. 6, p. 921. It occurs in the Old Red Sandstone series, near Dorpat, in Livonia, on the borders of the River Oredège, near Gatschina, and in the micaceous argillaceous limestone co-ordinated with the Old Red Sandstone, at Sivoritzy, near Gatschina, in the Government of St. Petersburg. *Lingula* also accompanies *Holoptychius* and *Pterichthys*, in Devonian marls and sandstones, underlying the Coal-measures, in the Gouvernement Nowgorod, on the Prykscha, near Scherechowitschi. (G. von Helmersen, 'Mém. Acad. Imp. Sc. St. Petersb.,' vol. iii, No. 9, p. 22, 1860.

[1] In the Index to the 'Geology of Russia,' &c., the word "vertical" before "Devonian beds containing Ichthyolites" should be erased, as the beds are almost horizontal.

The little River Pehrse, which there empties itself into the Düna, runs in a deep gorge, in which many beds of impure concretionary limestone are seen to alternate with courses of calcareous shale or marl. These alternating strata, occupying a thickness of about 100 feet, repose on a band of arenaceous limestone, distinguished by impressions of fucoid-like or polypiform bodies, and beneath it is a bed of concretionary limestone with marly limestone, in which are remains of *Ctenacanthus serrulatus* (Ag.) and *Osteolepis*, &c., both of which genera occur in the Old Red Sandstone of Scotland."

The marls of Kokenhusen are referred to by Col. G. von Helmersen, in a work on the geology of the central parts of Russia.[1]

At p. 71, he says :—" The Devonian formation towards the east (as far as is known to me) consists of the same dolomites, calcareous beds, and marls, as occur near Kokenhusen, of which on the Schelon only the lower member is conspicuous, and particularly the marls are much developed." The marl, he says at pp. 72 and 73, is " one of the lowest beds of all the Devonian calcareous strata; it is characterised at places by *Spirifer Anossoffi*, *Sp. Archiaci*, *Orthis crenistria*, *Murchisoniæ*, *Euomphalus Voroneiensis*, corals, and some few fish-remains. On the Dwina, a similar bed appears to correspond with this blue marl; it contains, besides very numerous fish-remains, only *Lingula bicarinata* and *Posidonia* (*rugosa*, Kut.). It rests immediately on the sandstone of the Devonian formation, which, so largely developed in Livland, is altogether wanting on the Don and Woronesh." At pages 41, 44, &c., Von Helmersen also gives sections seen at Mzensk, Jefremow, &c., where the marls are intercalated with limestone, and rest on a limestone that has *Spirifer Anossoffi*, *Serpula*, *Nucula*, corals, and some fish-remains.

On the River Torgel, in Livland, Dr. Pander found that the hard white sandstone, used for grindstones, contains fine remains of *Asterolepis* (Pander), and that the overlying bluish marls and clays contains scales and teeth of *Osteolepis*, *Dipterus*, and *Glyptolepis*, in company with the *Asmusia membranacea* of Pacht. 'Ueber d. Saurodipt,' &c., 1860, p. IV.

Through the kind intervention of Col. G. von Helmersen, I have been favoured with the following bibliographic history of *Asmusia membranacea*, drawn up by Dr. Ch. Pander, the eminent palichthyologist, who has taken much interest in this species, has himself recognised its crustacean character, and has courteously favoured me with some specimens from Kokenhusen :

[1] 'Geognostische Untersuchungen in der mittleren Gouvernements Russlands, zwischen der Düna und Wolga, in der Jahren, 1850 und 1853, ausgeführt von G. v. Helmersen und R. Pacht.' [Including R. Pacht's 'Geognostische Untersuchungen zwischen Orel, Woronasch, und Simbirsk im Jahre, 1853.'] Herausgegeben von G. v. Helmersen. Gedruckt auf Verfügung der Kaiserlichen Akademie der Wissenschaften. ('Beitrage zur Kenntniss des Russischen Reiches und der angränzenden Länder Asiens,' 21. Bänchen.) 8vo, St. Petersburg, 1858.

In this work are included some of the results of the labours of that promising young geologist and traveller, Raimund Pacht, above named, who, we regret to learn, from Col. von Helmersen's Introduction to the 'Geogn. Untersuch.' died in 1854, at the early age of thirty-one.

"In the marls near Kokenhusen on the Pehrse, which lie on the lowest Devonian sandstone, form the lowest member of the Devonian limestone, and are particularly rich in the remains of *Osteolepis*, *Diplexus*, *Asterolepis*, &c., occur little bivalves, often in immense quantities, which Eichwald, in his 'Geognosie von Russland,' published (in the Russian language) in 1846, p. 339, referred to *Posidonomya*.

"Pacht, unaware of this determination, formed of these bivalves a new genus, which he called *Asmusia;* and the species, on account of the thinness of the shell, he called *membranacea;* 'Der devonische Kalk in Livland,' 1849, p. 44.

"Afterwards, finding that this animal had been already referred to *Posidonomya*, he gave up his new genus, in his memoir 'Ueber *Dimerocrinites oligoptilus*,' 1852, p. 26, and kept the name *Posidonomya*. In the same year this species appeared as *Posidonomya rugosa* in Kutorga's 'Geognostische Karte des Gouvernements von Petersburg,' and as *Posidonomya membranacea* in Pacht's new edition of his 'Der devonische Kalk in Livland,' 1859, p. 44, where it is accurately described, and illustrated by fig. 7 on the plate accompanying his memoir, but not with exactness.

"On account of Rupert Jones's researches on *Estheria minuta* in 1855, by which I was made aware that *Posidonomya minuta* of the Trias is a Crustacean, I examined carefully under the microscope this so-called *Posidonomya*, and found clearly that its tissue corresponded, not to that of the *Acephala*, but to that of the *Crustacea*. I considered, however, judging from its outer form, that this creature could not be allied to *Estheria*, from which it differs by its straight hinge-border; and I was therefore uneasy in retaining for it the name given by Pacht. In this mind I have treated of *Asmusia membranacea* as a Crustacean, and not as an Acephalous Mollusc.

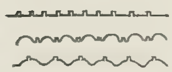
"This animal is clearly identical with that figured by Hugh Miller in his 'Old Red Sandstone,' pl. v, fig. 7. Should this be the case, it would, as I have formerly indicated, contribute much to the correlation of the Caithness shales, so rich in fish-remains, with the marls of Kokenhusen, which have an equally rich ichthyological fauna."[1] [CHRISTIAN PANDER, $\frac{27 \text{ Oct.}}{8 \text{ Nov.}}$, 1861.]

Asmusia membranacea from the sandy clay of Kokenhusen, is the same as the *Estheria* from the harder and more coarsely grained flagstones of Caithness. In the fine-grained deposit of Kokenhusen, the shell is very thin and of a light amber-colour, and being much less affected by the pressure of sand-grains, though often much crumpled, exhibits here and there faint traces of a regular ornament of a vertical wrinkly reticulation between the ridges (fig. 7). Owing to the difference in the matrix and mode of preservation, in the Russian specimens, the thin upstanding concentric riblets, are better preserved than in the flagstones of Caithness, and therefore form a prominent feature, which in the

[1] A neatly executed sketch, in water-colours, of the Kokenhusen fossil has been kindly communicated to me by Dr. Pander (through Col. von Helmersen), agreeing very closely with our fig. 6 (drawn under the *camera-lucida*), but showing eighteen, instead of about fourteen ridges. The sketch also indicates the shorter and the longer varieties of form, such as we have observed among the specimens from Caithness (compare figs. 2 and 3).

other case is replaced by a modification of the ridges and broad intervening furrows, which are squeezed up into rounded wrinkles (see woodcut, fig. 1).

Fig. 1. *Diagram showing the relative position of the Ridges and Interspaces in the shell of the* Estheria.



a.
b.
c.

a. Section of the Ridges and Interspaces in a fresh carapace-valve.

b. In some fossilized valves, the Interspaces are squeezed up, leaving the Ridges in between.

c. In other specimens the Interspaces are depressed when the shell is crumpled, and the Ridges are irregularly upraised.

Not being as yet able to discern any essential difference between the carapace-valves of the recent *Estheriæ* and the fossil from Kokenhusen and from Caithness, I do not think that the generic term "Asmusia" is required.

I cannot find that the term "membranacea" (belonging to a Wealden *Cyclas*) has been specifically applied to an *Estheria* of the Wealden, though often misapplied in collections; and I cannot substantiate the remark I made on that point in 1859 ('Quart. Journ. Geol. Soc.,' vol. xv, p. 406). The term "membranacea" remains, therefore, for R. Pacht's species before us.

Habitat of Estheria membranacea.—In the Estherian flagstones of Caithness we have no evidence of any marine characters, nor does their being associated with some thousand feet of sandstones and conglomerates render it impossible that they themselves should have been formed in fresh or brackish water. The occurrence of the fishes of the Old Red series of Caithness in Russian deposits with marine shells does not necessarily prove the marine nature of these Fishes, which may have had freshwater habitats, but have been hurried out to sea by floods; or, indeed, may have lived both in salt and in fresh water periodically. On the other hand, the "traces of *Lingula bicarinata*," in the Estherian sandy clay of Kokenhusen, point, at first sight, towards marine conditions. They may, however, have been "derived" fossils—fragments washed out of some older formation; or the *Estheriæ* may have been brought by flood or freshet low down the old estuary towards the habitat of the *Lingulæ;* or the *Lingulæ* may have had temporary lodging there whilst the sea held the estuary at times; or they may both have lived in brackish water: for we shall find further on, in the history of *Lingula tenuissima* of the Muschelkalk, some evidence of its having become subjected to such conditions. The same may be said for the fish-bed, with *Lingula* and "Posidonia," on the Dwina, mentioned by Helmersen (see p. 20).

On the Torgel (p. 20), fishes only are the associates of the "Asmusia;" and these cannot be regarded, in the present state of knowledge respecting them, as direct evidence either of the freshwater or the marine character of the deposit. In fact, their existing congeners, whether Polypterids or Silurids, affect lakes and rivers.

Note.—Since Mr. C. Peach wrote to me in 1861 on the subject (p. 17), he has found *Estheria membranacea* in three other quarries in the parish of Wick. The first is near the blacksmith's shop, Kilmster; the second is about a mile beyond this; and the third is near the halfway-house between Wick and John-o'-Groats. The distance between the first and last quarry is at least four miles, and this not in the line of strike of the beds. *Dipterus, Diplopterus, Osteolepis, Glyptolepis,* and *Coccosteus,* with land plants, are also found in these quarries.

2. Estheria striata, *Münster*, sp. Pl. I, figs. 8—18.

Sanguinolaria striata, *Münster and Goldfuss.* 1826, Petref. Germaniæ, II, p. 280, pl. 159, fig. 19.
Cardiomorpha striata, *De Koninck.* 1842, Anim. Fossil. Ter. Carbonif. Belgique, p. 105, pl. H, fig. 9, *a, b, c.*

Amongst the many fossil Bivalves of the Upper and Lower Carboniferous strata there are several that more or less resemble small Unios; and these have been subjected to much change of nomenclature. One of the smallest and thinnest of these, usually represented by a mere impression, though occasionally a film of carbonate of lime has replaced the shell, is *Sanguinolaria striata* of Münster, from the Mountain-limestone series of Regnitzlosau, near Hof, Bavaria. This was figured and described by Goldfuss; and again described and illustrated by De Koninck, who found it in the carbonaceous shales of the Mountain-limestone of Visé, Belgium. Being able to recognise the umbonal area of the closed valves,[1] De Koninck referred this fossil to his genus *Cardiomorpha.*

I have seen numerous specimens of this fossil from several localities, and from different horizons of the Carboniferous system of strata. Frequently they appear as conspicuous black and shiny impressions on the dark-coloured shales; sometimes they are obscure and dull; not unfrequently there are compressed casts of the bivalve; occasionally the thin shell has been converted into carbonate of lime; or a rusty film may sometimes represent the shell; usually the two valves have been only slightly displaced (Pl. I, fig. 9). The very numerous concentric striæ on these fossils is a striking feature; also the absence of relatively large, concentric, rounded ribs among these striæ, though some of the latter stand out stronger than the others, and at nearly regular distances apart (figs. 10, 12, 14). Compared with those shells of small *Aviculæ*, *Posidonomyæ*, and *Anthracopteræ*,[2] that have been wrinkled by pressure, the fossils under notice characteristically differ, by being less subject than the former to coarse and irregular transverse wrinklings. In one instance (in the shales from Lammerton, Berwickshire) we have some trace of structure in the film representing the shells (figs. 16, 17); by this fact, together with the Estherian character of the crowded striæ (a feature not unusual in *Estheriæ;* see Pl. II, figs. 28—31; Pl. III, figs. 6, 13, 23; Pl. IV, figs. 1—3), I am induced to regard these little fossils as remains of *Estheriæ;* and their tenuity, their gregariousness, and their association with fish-remains,[3]

[1] De Koninck states that he saw the "hinge:" I doubt that he means the hinge itself (which is said to be edentulous in *Cardiomorpha,* having only a narrow ligamental furrow, and an obscure internal cartilage-groove); but he probably refers to the collocated umbos represented in his fig. 9 *b.*

[2] Mr. Salter's name for the *Myalinæ* of his "Notes on the Fossils of the Iron-stones of South Wales," 'Geol. Surv. Mem.,' 1861.

[3] The occurrence of Bivalved Entomostracans in company with fish-remains is frequent in the fossil state, and agrees with the known habits of these animals. The *Entomostraca,* like other *Crustacea,* act as scavengers among dead molluscs and fishes; and are an important article of food to many fishes.

favour this view. Moreover, there are smaller *Estheriæ*[1] in the Carboniferous strata, showing their characteristic features (Pl. II, figs. 39, and Pl. V, figs. 1—7) more clearly, just as the small *Estheria elliptica* of the Wealden (Pl. IV, figs. 6, 7) exhibits a sculptured ornament, whilst the larger specimens have the surface obscured by thickly set striæ (figs. 1—5). *E. striata*, also, like other *Estheriæ*, has subquadrate individuals (see p. 11).

Estheria striata may be thus characterised:

Carapace-valves thin, nearly oblong, but somewhat higher at the posterior third than anteriorly; umbo distinct, placed forward, being situated at the antero-dorsal angle, beyond which the convexity of the anterior border projects but slightly; posterior border boldly rounded, usually more or less elliptical and oblique; ventral border gently and obliquely convex. The surface of the valves presents numerous concentric wrinkles (30—50 or more), some of which appear to be the raised ridges usual in *Estheriæ*, and the others are due to finer intermediate striæ (figs. 10, 12, and 14). The surface is frequently found to be wrinkled transversely (as in figs. 10 and 14) with very delicate corrugations crossing the concentric ornament, and due to mechanical causes. Coarser wrinkles, also due to the crumpled state of the fossil valves, are often seen (as in fig. 12); the latter seem to affect the inner portion of the shell, which (as we see by figs. 16 and 17) sometimes shows a cellular appearance analogous to the reticulate structure of crustacean shell. This reticular tissue is found freely dispersed on the shale from Lammerton, over some portions where but little other trace of the Estherian valve itself remains. Where the boundaries of the meshes make strong lines parallel with the concentric lines of growth of the shell (as in fig. 17), the fine intermediate striæ of the surface would probably be stronger than where the reticulation is irregular, as in fig. 16.

Of *E. striata* I have seen numerous specimens from several different localities; namely,—1. From Lammerton, Berwickshire; in bituminous shales belonging to the Mountain-limestone series. 2. From the Lanarkshire coal-field (in cannel-coal). 3. From Silesia, in carbonaceous shales of the Lower Coal-measures. 4. From two places in Lancashire, in cannel-coal of the Middle Coal-measures, and in bituminous shale of the Lower Coal-measures. 5. From near Chesterfield, Derbyshire, in carbonaceous shale of the Lower Coal-measures.

Differences of outline are to be observed among the various individuals; and some of these variations appear to be limited to one or other of the groups of specimens from the five localities mentioned. It is convenient, therefore, to seize these distinctions, slight as they are, and certainly not of specific value (nothing of the body and limbs of animals remaining to help our judgment), and make them serviceable in the recognition of the several very similar forms of carapace from widely separate places, and from at least four distinct horizons in the Carboniferous group of strata.

[1] As the smaller specimens are not found in company with the larger *E. striatæ*, I have kept them specifically apart. Were it otherwise, no distinction of great value could be easily described, and they might be regarded as young forms.

Estheria striata, Var. Beinertiana. Pl. I, figs. 11—14.

	Inch.			Inch.	
Height of valve,	$\frac{1}{6}$	Proportion 3 to 5, or 1 : $1\frac{1}{2}$ +	Height.........	$\frac{1\frac{1}{4}}{6}$	Proportion 2 to 3, or 1 : $1\frac{1}{2}$.
Length, about	$\frac{1\frac{1}{2}}{6}$		Length nearly	$\frac{2}{6}$	

Carapace-valves obliquely subovate; posterior half much higher than the anterior; postero-ventral angle produced, with an oblique elliptical outline.

This is very similar to the figures of *Estheria (Cardiomorpha) striata* given by Goldfuss and De Koninck.

1. Figs. 11, 12. This specimen is in hard black shale from Shaly Brow, not far from Wigan, and near Rainford and Billinge, Lancashire; collected by Mr. E. W. Binney, F.R.S., F.G.S., at the pit's mouth (see page 29, for the position of this shale in the Lower Coal-measures).

2. Figs. 13, 14, are taken from specimens crowded on the surface-planes of a dark-coloured, hard, stony shale, belonging to the Lower Coal-measures, and from the 21st level of the Rudolph Pit at Volpersdorf, near Neurode, in the Duchy of Glatz, Silesia.[1] These *Estheriæ*, from the lowest of the Silesian coal-beds, were found by the able geologist and botanist, Dr. Beinert, of Charlottenbrunn, who has carefully studied the Coal-measures of Waldenburg and Glatz; and they were communicated to me by our mutual friend, Dr. H. B. Geinitz, of Dresden, in 1859.

3. This variety has also been found by Mr. Binney in Mr. Hulton's cannel-coal, at Hulton Lane-ends, near Bolton-le-Moors, *Estheriæ* lying in numbers on one surface-plane; and fragments of a similar shell have been found in the cannel-coal at Moss House, two and a half miles S.W. of Bolton (Mr. Salter). I have also seen, from Mr. Binney's collection, this *Estheria* in cannel-coal from Ince, near Wigan, on two surface-planes two inches apart. According to Mr. Binney, it is always associated with remains of Fishes of the genera *Megalichthys*, *Rhizodus*, *Holoptychius*, *Cœlacanthus*, and *Palæoniscus*, as well as of Placoid Fishes. Mr. J. Rofe, F.G.S., also has given me a specimen of Wigan cannel containing a band of this *Estheria*, associated with a Fish-tooth. This specimen was from the middle of a two-foot bed of cannel, the top of which is covered by a layer of Fish-remains, about an inch thick. In this instance, some of the carapace-valves are represented by very thin films of whitish carbonate of lime, having the striated pattern of the impressions.

4. Another occurrence of this, or a closely allied, variety is indicated by a specimen of cannel-coal (bearing numerous *Estheriæ* on one surface-plane, and grey fish-scales on another, half-an-inch distant), from Carluke, Lanarkshire, which was collected by Mr. Binney, on a pit-bank, where a coal lying just above the Mountain-limestone series was being worked.

[1] Some of the coal-beds of this district have been fully described by Beinert and Goeppert in the 'Nat. Verhand. Holland. Maats. Wetens. Haarlem,' vol. v, part 2, 1849.

ESTHERIA STRIATA, Var. TATEANA. Pl. I, figs. 15—18.

	Inch.			Inch.	
Height of valve,	$\frac{1}{6}$	Proportion 2 to 3, or 1 : $1\frac{1}{2}$	Height	$\frac{1\frac{1}{2}}{12}$	Proportion 5 to 7, or 1 : $1\frac{1}{2}$—.
Length	$\frac{1\frac{1}{2}}{6}$		Length	$\frac{2\frac{1}{2}}{12}$	

Height, nearly...... $\frac{1}{10}$ inch } Proportion 11 to 14, or 1 :1 +.
Length, more than $\frac{1}{10}$,, }

Carapace-valves nearly oblong, but higher at the posterior third than anteriorly, boldly rounded behind with a semicircular outline, obliquely rounded in front. Fig. 18 represents a shorter carapace than fig. 15; and some appear to have been even shorter, and of a more rounded form, than this. We have a corresponding occurrence of oblong or subovate, in company with subquadrate, forms of Estherian carapace in the case of the Rhætic *E. Mangaliensis* of India (Pl. II, figs. 16 and 20), and the Wealden *E. elliptica* (Pl. IV, figs. 1 and 3). The outlines of the specimens figured may have been slightly altered by pressure, but they are far more perfect than the majority of those I have seen from Lammerton.

FIG. 2.

Sketch of a subquadrate individual of Estheria striata, *from Lammerton, Berwickshire.*

(Magnified 6 diameters.)

The specimens of *Estheria striata*, var. *Tateana*, were kindly submitted to me by their discoverer, Mr. George Tate, F.G.S., of Alnwick, some years since. They are numerous, but obscure, occurring either as impressions or as thin rusty films, or as a faint reticulate tissue, in a black and somewhat bituminous shale. They seem to have been originally densely crowded; and are associated with Fish-remains, *Spirorbis carbonarius*, and impressions of Plant-stems. The shale belongs to the Mountain-limestone series, and comes from Lammerton, in Berwickshire.

To render the geological position of these *Estheriæ* quite plain, Mr. Tate has obliged me with a succinct account of the strata and fossils observed by him in the section where these shales are met with. He says—

"The dark carbonaceous shale containing *Estheriæ* is exposed in the cliff along the Berwickshire coast for upwards of a mile; it is accessible, however, only at a few points; and *Estheria* has apparently but a limited distribution in the bed. I have found it only near Lammerton. The section here, is as follows (in descending order):—

	Feet.	Inches.
1. Reddish sandstone	90	0
2. Dark carbonaceous shale, with *Estheriæ;* where thickest, it is generally hard and flaggy	12	0
3. Limestone, fossiliferous; usually of a dun colour, and weathering buff	4	0

		Feet.	Inches.
4.	Coal, not exceeding	0	7
5.	Fire-clay, with Stigmarian rootlets	5	0
6.	Reddish sandstone; many of the beds thin and slaty	30	0
7.	Shales, with a little poor ironstone	4	0
8.	Coal (irregular)	0	10
9.	Yellow sandstone	4	0
10.	Drab, slaty sandstone, passing into argillaceo-arenaceous shale	10	0
11.	Arenaceous shale, slightly calcareous	3	0

"These beds dip east by south; all of them belong to the Mountain-limestone group, though they are not far from its base.

"No. 1. This sandstone is overlain by many beds of limestone, and associated with sandstones, shales, and coals, which form the mass of the Mountain-limestone group, extending into Northumberland.

"No. 2. The Estherian shale. This contains another Entomostracan form.[1] There are also a number of broken fragments of plants; the most numerous being reed-like stems, longitudinally ribbed, but without joints, *Coniferites verticillatus* (Tate[2]), and *Sphenopteris Johnstoniana* (Tate[3]). Attached to the plant-stems are species of *Spirorbis.* Scales of Ganoid Fishes are abundant; and I have determined teeth and scales of *Holoptychius Hibberti* in this shale. In the lower part of the deposit I found *Chonetes sordida* and *Nucula gibbosa.* This bed, taken in connection with that below it, shows changes of conditions from marine to estuarine, and probably to fresh water.

"No. 3. This limestone is very fossiliferous, containing—

Strophomena analoga.
Productus giganteus.
Productus semireticulatus.
Lithodendron junceum.
Lithodendron affine.
Lithostrotion Portlocki.
Stenopora tumida.
Favosites parasitica.
Astræopora cyclostoma.
Syringopora geniculata.
Aulopora gigas.[4]

"No. 10. In the arenaceous shales I have found *Lingula squamiformis,* and an elongated form allied to, but which may be different from, *Lingula mytiloides.*

"No. 11. Here occurs *Discina nitida.* In several of the beds of Nos. 10 and 11 are many Annelid-borings.

"In arenaceous shales a few yards below the above section, I have found *Sanguinolites arcuata*, *S. carbonaria*, *Aviculo-pecten Pera*, and *Spirifer laminosus.*" [G. Tate, February 9th, 1861.]

[1] See Appendix.

[2] 'Fossil Flora of the Eastern Border,' p. 309.

[3] Ibid., p. 306.

[4] 'Transact. Berwickshire Nat. Club,' vol. iv, p. 152—154.

Estheria striata, Var. Binneyana. Pl. I, figs. 8—10.

Height of valve, $\frac{7}{12}$ inch	}	Proportion 7 to 12, or 1 : $1\frac{3}{4}$ —.
Length............ 1 „		

Carapace-valves oblong; upper and lower margins nearly parallel; ends slightly rounded; three times as large as the other varieties; attaining a length of one inch. The largest recent *Estheria* that I know (*E. Melitensis*) is scarcely more than half an inch long.

In black, laminated, carbonaceous shale: specimens numerous on the planes of bedding. Found by Mr. E. W. Binney, at an ironstone-pit at Lowndsley Green, near Chesterfield, Derbyshire. This Estherian shale lies between the Winn-Moor Coal, below, and the Black Shale or Silkstone Bed above, a distance of about 70 yards.

To illustrate the geological position of the English specimens of *Estheria striata*, Mr. Binney has supplied me with a section of the strata of the lower part of the Middle, and the whole of the Lower Coal-measures of Lancashire. In a paper on the Permian beds of the North-west of England,[1] he has described all the divisions of the Lancashire Coal-field, Upper, Middle, and Lower; and a still more detailed account of the last may be found in another paper by him, on some Trails and Holes in some of the Carboniferous strata, and on *Microconchus carbonarius*.[2]

"The following section of the Coal-measures of Lancashire, in a descending order, commences with the strata just above the 'Wigan Cannel,' a 'mine' about 220 yards above the 'Arley Mine' of Wigan, or 'Silkstone Coal' of Yorkshire, the lowest coal of the Middle Field.

	Yds.	ft.	in.	
"Dark-grey shale	2	0	3	Contains *Megaphyton distans, Ulodendron majus,* and other coal-plants.
Black bass and inferior cannel-coal ...	2	0	6	The basses and cannels contain, in addition to *Estheria*, fishes of the genera *Megalichthys, Rhizodus, Holoptychius, Cœlacanthus,* and *Palæoniscus,* as well as remains of numerous Placoid fishes, generally found associated in Lancashire with the so-called *Unionidæ*, but in Scotland (at Charlestown) found with *Productæ, Spiriferæ,* and such marine shells.
Coarse cannel...............................	0	0	2	
Good cannel (with *Estheriæ*[3])	2	2	0	

[1] 'Mem. Lit. Phil. Soc. Manchester,' 2d series, vol. xii, p. 209, &c. 1855.

[2] Ibid., 2d series, vol. x, p. 181, &c. 1852. Mr. Binney also refers me to the Report to the Home-Secretary, for the year ending 1858, by Mr. Joseph Dickinson, F.G.S., one of H. M. Inspectors of Coal-mines, as containing a good series of sections of the Lancashire Coal-field. In his 'Coal-fields of Great Britain,' and in the 'Memoirs of the Geological Survey of Great Britain, 1860,' Mr. E. Hull, F.G.S., has supplied some useful information respecting the same Coal-field. See also the 'Geol. Survey Map,' Sheet 89 S.E., and Explanations.

[3] From Hulton Lane Ends, and Ince Hall, near Wigan (Mr. Binney and Mr. Rofe).

		Yds.	ft.	in.	
	Earth	0	0	9	
King-coal.	Coal	0	0	8	
King-coal.	Bass	0	0	8	
King-coal.	Coal	0	2	0	
King-coal.	Bass	0	2	0	
King-coal.	Coal	0	1	6	
	Grey warren earth	6	2	0	
	Various strata and coal	214	0	0	
	Arley coal	1	1	0	
	(Bottom of the middle portion of the Coal-measures.)				
	Strata	5	0	0	
	Coal	0	0	3	
	Strata	30	0	0	
	Coal	0	0	3	
	Strata	53	0	0	(This is the horizon to which the *Estherian shale* found at Lowndsley Green, Chesterfield, belongs; see p. 28.)
	Coal	0	0	2	
	Strata	68	0	0	
	Coal	0	0	3	
	Strata	57	0	0	
	Coal	0	0	6	
	Strata, estimated about	80	0	0	The lower part, forming the roof of the coal, sometimes contains *Aviculo-pecten*, *Goniatites*, &c. *Estheriæ ?* (See below.)
	Forty-yards Coal	0	1	6	
	Strata	34	0	0	
	Upper Foot Coal, with balls	0	1	0	*Aviculo-pecten*, *Goniatites*, &c., in the roof.
	Strata	12	0	0	
	Ganister Coal	0	0	0	*Aviculo-pecten*, *Goniatites*, &c., sometimes occur in the roof; and often, shells resembling *Lingula*, *Modiola*, &c.
	Strata	16	0	0	
	Lower Foot Coal, or Spanish-juice Coal	0	1	6	
	Strata	16	0	0	
	Bassy Coal, or Salt's Coal	1	0	2	*Aviculo-pecten*, *Goniatites*, &c., in the "roof" sometimes; but generally shells of *Unionidæ* (?), with fish-remains: also *Cypridæ*, with *Microconchus carbonarius*, in some of the roof-shale; also *Estheriæ*.[1]
	Strata	40	0	0	
	Coal	0	0	9	*Aviculo-pecten* and *Goniatites*.
	Shales	4	0	0	*Aviculo-pecten* and *Goniatites*, sometimes.

[1] Mr. Binney thinks that the Estherian shale of Shaly Brow is from this roof; but some other geologists think that it is from the roof of the Forty-yards Coal above.

	Yds.	ft.	in.	
"Rough Rock" of the Lancashire geologists, "Upper Millstone-grit" of the Geological Surveyors …………	6	0	0	
Sand-delph Coal, or Feather-edge Coal.	0	1	6	The roof is generally a grit-stone; but at Birtle Dean, near Bury, it is a shale with *Aviculo-pecten*, &c.
Rough rock …………………………	20	0	0	
Lower flags and shales ………………	120	0	0	
Coal………………………………………	0	0	6	*Aviculo-pecten, Goniatites*, &c.
Shale .. ………………………………	2	0	0	
Coal………………………………………	0	0	8	
Black shale…………………………	8	0	0	
Black shale and sandstone……………	6	0	0	
Coal………………………………………	0	1	3	
Shale ………………………………	4	0	0	
"Upper Millstone-grit" of the Lancashire geologists ……………………	60	0	0	
Dark shale …………………………	40	0	0	
Coal………………………………………	0	0	4	
Dark shale …………………………	15	0	0	
Coal………………………………………	0	0	8	
Dark shale …………………………	6	0	0	
"Lower Millstone-grit," with its partings……………………………………	130	0	0	
Limestone-shale, containing beds of grit-stone …………………………	300	0	0	[E. W. Binney, Feb. 7, 1860.]

Habitat of E. striata.—With regard to the possibly freshwater or marine character of the *Estheria striata*, above treated of, as indicated by its associates, I can only say that, excepting the occasional proximity of those dubiously marine forms, the *Anthracosiæ* and *Anthracomyæ*, and the presence of *Spirorbis* at Lammerton, sea-shells are wanting in the shales and cannel-coal in which this *Estheria* has been found.

In the 'Lethæa Rossica,' livr. vi, 1859, p. 90, Mr. Eichwald describes under the name of "*Posidonomya minuta*, Goldfuss," what may prove to be an Estherian fossil from shale apparently belonging to the Carboniferous Formation, near Izoume, in the government of Kharkof." It measures 1—1¾ line in one diameter, and 1 line in the other. The valves are described as being horny, deep-brown, oblique, very thin, and very small; rather broader than long, rounded on the inferior border, nearly straight on the superior, and without an anterior ear; surface wrinkled with concentric (8—10) ridges, somewhat deep, unequal, concentric to the umbos, which are scarcely distinguished.

3. Estheria tenella, *Jordan*, sp. Plate I, figs. 26, 27; Pl. II, fig. 39; and Pl. 5, figs. 1—7.

Posidonia (?), *Michelin.* Bullet. Soc. Géol. France, 1836, vol. vii, p. 321.
Cypris, *A. D'Orbigny*, 1845; *Landriot.* Ibid., 2d series, 1849, vol. vi, p. 90.
— *Naumann.* Ibid., 2d series, 1848, vol. v, p. 301.
Posidonomya tenella, *Jordan and H. G. Bronn.* Neues Jahrb. f. Min., 1850, p. 577.
[? Estheria exigua, *Eichwald*, sp. See p. 37].

From the Murgthal and from Astley (Lancashire)	Height of valve, less than $\frac{1}{12}$ inch Length, rather more than $\frac{1}{12}$,,	Proportion 5 to 7, or 1 : $1\frac{1}{2}$—
From Bradford (Lancashire)	Height, more than $\frac{1}{12}$,, Length, less than $\frac{1\frac{1}{2}}{12}$,,	,, 13 to 17, or 1 : $1\frac{1}{3}$—
From Oschatz	Height $\frac{1\frac{1}{3}}{12}$,, Length, less than $\frac{2}{12}$,,	,, 8 to 11, or 1 : $1\frac{1}{2}$—
From Lanarkshire	Height, less than $\frac{3}{24}$,, Length, less than $\frac{4}{24}$,,	,, 17 to 23, or 1 : $1\frac{1}{3}$+
From Bradford (Lancashire)	Height $\frac{3}{24}$,, Length, more than $\frac{4}{24}$,,	,, 9 to 13, or 1 : $1\frac{1}{2}$—
From Bradford (Lancashire)	Height, more than $\frac{3}{24}$,, Length $\frac{5}{24}$,,	,, 21 to 30, or 1 : $1\frac{1}{2}$—

Carapace-valves broadly subovate, oblong, or nearly quadrate; hinge-line straight, but rounding off before and behind insensibly into the well rounded extremities, which are nearly symmetrically, but unequally, curved. The umbo is forward, at the front end of the hinge-line, and does not interfere with the outline of the valve. Concentric ridges about 15; interspaces minutely pitted by the meshes of a delicate reticulation.

This *Estheria* occurs at several localities, and is essentially a member of the "Carboniferous" fauna, though it is found also in beds referred by some to the Permian formation (Oschatz, Autun, and ? Russia).

1. In the 'Neues Jahrbuch f. Min.,' &c., 1850, p. 577, Prof. H. G. Bronn gives an account of the black shales of Sulzbach, Lebach, &c., and describes *Posidonomya tenella* (Jordan) which there occurs in company with the interesting crustacean *Gampsonyx fimbriatus*[1] (Jordan). "Posidonomya" is stated to lie very thickly on the faces of the shale; to be of an oblique-oval shape, 3—4 millimetres in length,[2] with 8-10-15 concentric wrinkles, which are the less numerous when they are large and strong; the hinge-border joining the hinder border with blunt but distinct angle. It is stated to be like *P. Becheri* in miniature, and to correspond in form and wrinkles to fig. 6 *a*, pl. 113, of Goldfuss's 'Petref.,' but of only half the size, and somewhat longer in proportion: the angles of the

[1] Palæontographica, vol. iv, p. 2.
[2] M. Jordan refers to some specimens 5 millem. ($2\frac{1}{4}$ lines, or $\frac{1}{5}$th inch) long; N. Jahrb. 1850, p. 578.

hinge-border, however, are said to be more distinct, and the ridges of the concentric wrinkles narrower and sharper; its length and height are as 4 : 3.

Prof. Fridolin Sandberger, of Carlsruhe, favoured me, in December, 1861, through the medium of Prof. H. G. Bronn, with some specimens of *E. tenella* from the Murgthal, Schwarzwald, labelled "From the uppermost beds of the Coal-formation, Sulzbach; Valley of the Murg. The place where it was found is now closed up." The specimens are of a black stony shale, or slate, with white streak. The *Estheriæ* are represented by black films and impressions of flattened valves lying crowded on the planes of bedding ($\frac{1}{4}$ inch apart), together with fish-scales, mica, and small decomposing crystals of pyrites.

The carapace-valves are but poorly represented, and have left no trace of their ornament in these specimens, one of which is figured, Pl. V, fig. 6.

2. A very similar form, from the Coal-measures of Lancashire, has lately been shown to me by my friend, Mr. Binney, who has so largely contributed to the series of palæozoic *Estheriæ* described in this monograph. On a small piece of fine-grained, micaceous, red, argillaceous sandstone, from Mr. Jackson's pit at Astley, Lancashire (midway between Wigan and Manchester), are several badly preserved casts of a small *Estheria* (Pl. V, fig. 5), associated with numerous casts of a *Beyrichia* (Pl. V, figs. 16, 17). "It is from the Upper Coal-measures, and was met with about 50 yards above the Four-foot Coal of Worsley, Pendleton, &c."

This little *Estheria* is apparently identical with that from the Murgthal.

3. A somewhat larger, but very similar *Estheria*, has been noticed by Mr. Salter lately in the shales of the Four-foot Coal of Bradford, near Manchester. Pl. V, fig. 1, represents one of the impressions from the shale; where they are not numerous, and are associated with *Anthracomya* (?) and *Cypridæ* (Pl. V, figs. 13, 14).

4. In the ironstone associated with the same coal there are similar *Estheriæ*, but still larger (Pl. V, figs. 2—4), which were also brought under my notice by my friend Mr. Salter. These are casts, but they retain faint traces of sculpturing (fig. 5), which appears to me to have been a reticulation, modified by pressure and crumpling, by which the interspaces have been thrown into short puckers parallel with the ridges.

The Four-foot Coal of Bradford, near Manchester, is regarded by Mr. Binney and other geologists, as being most probably equivalent to the Four-foot Coal of Pendleton and Worsley, and the Ellam's Coal near Ringley.[1] The Four-foot Coal is found at 115 yards from the pit's mouth at Agecroft Colliery; and the fire-clay above, and the clay-floor of the coal are full of *Stigmaria ficoides* (ibid., p. 161). The Four-foot Coal of Bradford, here referred to, is on the horizon of the Upper Coal-measures of Ardwick, near Manchester, and and is therefore near the top of the Upper Coal-measures.

[1] Binney, 'Transact. Geol. Soc. Manchester,' 1841, vol. i, pp. 70, 73, and 158. As the Manchester coal-field is cut off by strong faults from the neighbouring coal-fields, there is some uncertainty in the exact correlation of these seams of coal. Still, there is no doubt that they belong to the same upper portion of the Coal-measures. (See 'Map Geol. Survey,' Sheets 80 & 89.)

5. Intermediate in size between those of the ironstone and those of the shale of the Four-feet Coal, above mentioned, and better preserved, are some specimens of a similar *Estheria*, found by Mr. Grossart, of Salsburg, near Holytown, Lanarkshire, in the Coal-measures of Lanarkshire, Scotland. These are represented by shiny black impressions, readily affording traces of a delicately sculptured reticulate ornament (Pl. II, fig. 39, and Pl. V, fig. 7).

Mr. Grossart's specimens show the concentric ridges distinctly, twelve and upwards (Pl. II, fig. 39); as usual in adult *Estheriæ*, the ridges are crowded towards the ventral border. The interspaces bear a faint dotting, attributable to a delicate and minute reticulation (Pl. V, fig. 7); and in this they resemble those of *E. tenella* of Saxony (Pl. I, figs. 26, 27), to which also the *Estheria* under notice has a close resemblance in general form, except that it is not quite so oblong.

Of *E. tenella* from Lanarkshire, I have seen about a dozen individuals in a black shale. The specimens were discovered, and kindly submitted to my examination, by Mr. Grossart, who has also shown me several other *Entomostraca*, which he has discovered in the Coal-measures of that district.

In the 'Geologist,' vol. ii, 1859, p. 466, Mr. Davidson gives a tabular view of the Carboniferous Strata of the Clydesdale Coal-field (Lanarkshire). These are divisible into four great groups: 1. The Upper Coal-measures; 2. The Upper Limestone series; 3. The Lower Coal-measures; and 4. The Lower Limestone series. The Upper Coal-measures of Lanarkshire, in one band of which *Estheriæ* have been found by Mr. Grossart, is said to have, in some places, a thickness of about 159 fathoms. It contains eleven seams of workable coal, and numerous smaller seams; the "Ell Coal" one of the best known, is situated towards the top of the series. Besides the coals, this series consists of sandstones, for the most part white, or white with dark streaks, of fire-clays and shales, a bed of so-called freshwater limestone, and a few important bands of ironstone.

Mr. Grossart has sent me a list of the more important beds of this Upper Coal-measure series. The "Ell Coal" is taken as a recognisable horizon, and the distances above and below that coal are indicated in the table for the chief coals, shales, and ironstone. I have inserted the names of the *Entomostraca* with their respective beds. Most of the *Cypridæ* appear to be closely allied to *Cytheropsis* (?) *Scoto-Burdigalensis* or *C. suberecta;* but I have not yet been able to determine exactly the species, of which there appear to be about four or five.

Coal-measures of Lanarkshire.

Fathoms.	Upper Coal-measures.	
22	Palace-craig ironstone (Black band).	*Anthracosia acuta, Avicula,* and *Cytheropsis Scotoburdigalensis* (?).
16	Estheria-shale	*Anthracosia, Avicula, Spirorbis, Estheria.*
15	Upper coal.	
0	Ell coal	*Gyracanthus formosus,* here and below.
12	Main coal.	

Fathoms.	UPPER COAL-MEASURES.	
26	Splint coal.	*Anthracoptera quadrata*, here and below.
34	Coal.	
41	Ardrie black-band ironstone.	*Cytheropsis Scotoburdigalensis* (?).
55	Virtue-well coal.	
61	Bell-side ironstone[1] (Black-band).	
72	Mussel-band ironstone (in the following association of beds):	

Bituminous shale, with shells, *Cypridæ*, and fish	20	inches.
Ironstone (dark), with *Beyrichia arcuata*	2	,,
Bituminous-shale	5	,,
Parrot-coal	4	,,
Bituminous shale, with *Anthracosia acuta*	10	,,
Mussel-band, made up of *Anthracosiæ*	3	,,
Bituminous shale, with shells	2	,,
Ironstone, full of *Cytheropsis Scotoburdigalensis*	3	,,
Dark shale	9	,,
Coal	8	,,

78	Coal (sometimes ironstone).	
86	Shott's furnace-coal.	*Beyrichia arcuata.*
92	Shott's smithy-coal.	
100	Shott's low-coal.	
105	Shott's gas-coal.	*Cytheropsis Scotoburdigalensis* (?), and another, *Modiola*, and *Beyrichia arcuata.*
109	Black fossiliferous shale.	
113	Coal.	
121	Coal.	
124	Coal.	
134	Coal.	
144	Slaty ironstone (Black-band).	*Lingula, Discina, Conularia,* &c., together with Fish-remains, and *Anthrapalæmon Grossarti.*

(The distance and thickness of the beds vary considerably in different localities.)

Anthracosia acuta occurs in most of the beds below the Ell-coal; *Diplodus gibbosus*, *Megalichthys Hibberti*, *Holoptychius minor*, &c., are found in nearly all the beds of the Upper Coal-formation, but more abundantly below the Ell-coal. *Spirorbis carbonarius* occurs in most of the beds up to the Splint-coal.

In the "Upper Limestone series," an ironstone, at 200 fathoms below the Ell-coal (a few feet above the highest limestone), has yielded to Mr. Grossart a new *Beyrichia* (*B. fastigiata*, sp. nov.). At 343 fathoms below the Ell-coal, in the "Lower Limestone series," Dr. Rankine, of Carluke, gets *Beyrichia multiloba* (sp. nov.); and at about 350 fathoms, Mr. Grossart has found some small Cypridina-like Entomostraca, similar to the *Daphnoidia Hibberti* and *D. primæva*.

[1] Dr. Rankine, of Carluke, has sent me specimens from about this horizon, in the Clydesdale Basin, one of which has *Cytheres* and *Spirorbis*, and another *Beyrichia arcuata* and *Anthracomya* (?).

A similar fossil has been obtained at Gare, by Dr. Rankine, at 239 fathoms; and Dr. Rankine has also sent me specimens of a bed of *Cytheropsis Scotoburdigalensis*, associated with ironstone, from 356 fathoms below the Ell-coal.

6. Barely, if at all, distinguishable from the *Estheria* communicated by Mr. Grossart, is an *Estheria* occurring in great numbers in the Brandschiefer of Oschatz, Saxony, referred to the Permian Formation by Naumann and Geinitz, to whom I am indebted for specimens, one of which is figured Pl. I, figs. 26, 27.

Under the same name, therefore, I propose to describe the specimens of *Estheriæ* communicated to me by my friend, Dr. Geinitz, of Dresden, which he refers to the species described by Bronn as *Posidonomya tenella* of Jordan. Dr. Geinitz's species came from the Brandschiefer (bituminous shale) of Salhausen; Jordan's *P. tenella* occurs in black shales in the Murgthal, near Sulzbach (see page 31) and also, it is said, in the bituminous shales of Autun, in France. I have not seen specimens from the locality last named.

The Saxon specimens are numerous, but delicate and obscure; and I owe to Mr. George West's patient and accurate labour with the microscope, the distinct and characteristic delineations of this species (figs. 26 and 27), as well as of others nearly as obscure, and of the many other better preserved *Estheriæ* described in this monograph. The specimens were supplied by Prof. Naumann, and transmitted to me by Prof. H. B. Geinitz, in July, 1859, in most ready and obliging accordance with a request from me to be made acquainted with the Permian Entomostraca mentioned in the 'Steinkohlenformation in Sachsen,' p. 4.

These *Estheriæ* lie massed together in large numbers on the planes of bedding in a dark-coloured combustible shale, belonging to the Lower Permian formation of Saxony. The shale belongs to the coal-deposit known as the "Brandschiefer" of the Rothliegendes, at Salhausen, near Oschatz, Saxony; and, besides the *Estheria*, it contains remains of *Acanthodes gracilis*, Beyrich, *Xenacanthus Decheni*, Beyrich, *Walchia piniformis*, Schlotheim, *Odontopteris Naumanni*, Gutbier, &c.[1]

The following is a more detailed account of this interesting deposit of fossil fuel,—from Geinitz's 'Steinkohlenformation in Sachsen,'[2] 1856, p. 4.

"In the lower division of the Rothliegendes, a formation altogether distinct from the Coal-measures, and comprised with the Zechstein-group, in Murchison's Permian Formation, there is found at some places in Saxony a stratum which is sometimes a pure 'Brandschiefer,' sometimes an impure black coal, and which is much used for fuel. Von Gutbier, in his 'Versteinerungen des Rothliegenden in Sachsen,' 1849, pointed out that the Plant-remains found in this bed are specifically different from those of the Coal-measures.

"The Brandschiefer appears most developed near Salhausen, between Oschatz and Mügeln, where,

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[1] Professor H. B. Geinitz has obliged me with this information, in a letter dated January 22, 1861.

[2] An abstract of the chief points of this valuable work are given in General Portlock's 'Anniversary Address to the Geological Society of London,' 1857; and Dr. Geinitz's previous work on the Coal-beds of Hainich, Ebersdorf, and Floha, is noticed in Mr. Hamilton's address, 1855.

according to Naumann, it comprises six or seven beds, of which the greatest is eighteen feet thick. Naumann has described this carbonaceous shale in the first volume of his 'Lehrbuch der Geognosie,' (1849, p. 701), thus—'It varies in colour from blackish-brown to pitch-black; it is thinly and evenly laminated, therefore often splitting into very thin flakes and plates, glistening on the split faces, with greasy shining streak, easily shivering, somewhat soft, and so richly impregnated with bitumen that it burns in the fire with a more or less brisk, but very smoky, flame, without, however, falling to ashes.'

"Of Plant-remains in the Brandschiefer, the most abundant are *Lycopodites piniformis*, Schlot., and *Walchia filiciformis*, Schlot. Remains of Fish also occur—of the genera *Amblypterus*, *Holocanthodes*, *Xenacanthus*, and *Cephalaspis :* also there are the thin shells of a *Cypris*, very similar to the *Posidonomya minuta*.

"On these shells, which Bronn[1] has also found in a very similar black shale of the Murgthal, in great quantities, and which also abound in the bituminous fish-shales of Muse, near Autun (Saône-et-Loire), and Bruxière-la-Grue (Allier), in France, a lengthy discussion has been carried on by Delahaye and Landriot, as to whether they belong to the Molluscan genus *Posidonomya*, or to the Crustacean genus *Cypris*.[2]

"Without inquiring which is right in this question, we may remark that the contemporaneous occurrence of these beds at the localities mentioned, and especially their stratigraphical relations, prove their identity with those of Salhausen, which moreover must be paralleled with those occurring in the Rothliegendes, between Trautenau and Hohenelbe,[3] in Bohemia, and those near Oslawan, in Moravia."[4]

In the 'Bullet. Soc. Géol. France' (1848), 2e sér., vol. v, p. 301, Prof. Naumann mentioned the occurrence of this bituminous schist at Oschatz, and its little bivalved Crustacean,—the latter under the name of "Cypris," which had been also applied to it (according to M. Landriot[5]) by A. D'Orbigny, in 1845. Michelin had referred these shells to *Posidonia*, with some doubt, in 1836 (see 'Bullet. Soc. Géol. France,' 1836, vol. vii, p. 321; 2e sér., vol. v, p. 305; and 1850, vol. vii, p. 33).

The specimens from Saxony, in my possession, have features very similar to those above described, and present the characteristics of *Estheria*, especially the delicate concentric ridges, separated by flattened interspaces sculptured with a reticulate pattern. This is faint (Pl. I, fig. 27), and seems to be associated with a fine dotting. Taking one of the best of the specimens as a type (and they are all so much crushed, that it is difficult to find one with a trustworthy outline), this species seems to present an obliquely sub-quadrate valve, with the corners rounded off; nearly equilateral, but rather less fully rounded in front than behind. The umbo is situated in the anterior third of the hinge-line, which is straight, long (about two thirds the length of the valve), and defined by blunt angles on either end, at the downward curving of the front and hind borders respectively.

[1] Leonhard und Bronn's 'Jahrb. f. Min.,' 1850, p. 577; where they are referred to as *Posidonomya tenella*, Jordan.

[2] 'Bullet. Soc. Géol. France,' 2e sér., 1848, vol. v, p. 304; 1849, vol. vi, pp. 90, 374; 1850, vol. vii, p. 33.

[3] Girard, in Leonhard und Bronn's 'Jahrb.,' 1843, p. 757. Beyrich, 'Bericht. K. Preuss. Akad. Wiss.,' 1845, p. 25.

[4] Von Hauer, 'Sitzungsbericht. K. K. Akad. Wiss.' Wien, 1850, p. 160.

[5] 'Bullet. Soc. Géol. France,' 2e sér., 1849, vol. vi, p. 90.

7. Lastly, I have to draw attention to a very small Permian *Estheria* from Russia (Pl. I, figs. 23, 24), having some characters very similar to those above mentioned, and which may possibly be ultimately found to be of the same species. As I do not, however, feel satisfied that I have fully elucidated this *Estheria* (*E. exigua*), I prefer to keep it separate (see below). For specimens of this *Estheria*, I am indebted to M. E. D'Eichwald.

Estheria tenella may thus be said to occur—

In Russia (*E. exigua.*). Permian.
At Oschatz, Saxony. Permian (Rothliegende).
,, Autun, France. Permian (?) or Upper Carboniferous.
,, Salbach, Black Forest. Upper Carboniferous.
In Lancashire, England. Upper Carboniferous.
,, Lanarkshire, Scotland. Upper Carboniferous.

Habitat of E. tenella.—The *Beyrichiæ* at Astley (Lancashire), *Anthracomyæ* at Bradford (Lancashire), and *Anthracosia*, *Avicula*, and *Spirorbis*, in Lanarkshire, seem to point to at least a brackish water for *E. tenella*.

4. Estheria exigua, *Eichwald*, sp. Pl. I, figs. 22—24.

Posidonomya minuta (*Bronn.*), *Kutorga*. Verhand. Min. Gesell. St. Petersb., 1844, p. 63, &c., pl. 1, figs. 1—5.
— exigua, *D'Eichwald*. Geogn. Russl., 1846, p. 456; Leth. Rossica, 1855, livr. iv, p. 231; Bullet. Soc. Imp. Nat. Mosc., 1856, xxix, 2, p. 559; Leth. Ross., 1859, livr. vi, p. 941, pl. 40, fig. 4.
Cyclas Eos, *D'Eichwald*. Geogn. v. Russlands, 1846, p. 466.
Cytherina (Cyclas) Eos, *D'Eichwald*. Bullet. Soc. Imp. Nat. Moscou, xxx, part 2, 1857, p. 307.
Posidonomya Eos, *D'Eichwald*. Lethæa Rossica, 1859, livr. vi, p. 942, pl. 37, fig. 13.
[? Estheria tenella, *Jordan*, sp. See page 31.]

The figured specimen $\left\{\begin{array}{l}\text{Height of valve, } \frac{1}{48} \text{ inch} \\ \text{Length, ... } \frac{1\frac{3}{4}}{48} \text{ ,,}\end{array}\right\}$ Proportion 9 to 13, or 1 : $1\frac{1}{2}$—

The material at my command for the elucidation of this species is but limited. For what I have, I am indebted to the kindness of M. E. D'Eichwald, of St. Petersburg, who has courteously replied to my inquiries, and communicated specimens and information, both in the case of this and of other species of fossil *Estheriæ*. In January, 1861, M. D'Eichwald kindly favoured me with some specimens of light-grey marl, or calcareous shale, bearing remains both of *Estheria exigua* and *E. Eos*. The former is represented only by crumpled portions of the carapace. Of the latter, there are several minute individuals. Of these, which are delicate valves, beautifully iridescent under the micro-

scope, one has been carefully figured in Pl. I, figs. 22—24. It is very small, only $\frac{1}{84}$ inch in length; but, with great care, it can be made to show the ornament that is highly magnified in fig. 24. I believe that these minute *Estheriæ* are of the same species as the larger one on the same piece of marl; and that, therefore, two names are not required for them. The larger form is also very delicate, but it is thicker, and of a darker colour than the little specimens marked "*Posidonomya Eos*" by M. D'Eichwald; and the large specimen does not yield good microscopical evidence of ornament. Judging, however, by the probable collocation of large and small specimens of the same species, and by the absence of any important distinction (the relatively great size of the wrinkles being due to modification of a large specimen by pressure), I must regard both *P. exigua* and *P. Eos* as belonging to one and the same species of *Estheria.*

In communicating to me the above-mentioned specimens, M. D'Eichwald pointed out that, in his opinion, *Estheria Eos* has very fine and very numerous concentric ridges, and that "*Posidonomya*" *exigua* has strong ribs and broad furrows between them; and, though the former may probably be Crustacean, yet the latter at least, he still thinks, is really Molluscan. M. D'Eichwald also remarked, in his letter of January 19th, 1861, that the fig. 4, pl. 40, of his 'Lethæa Rossica,' represents the ridges as too small; they ought to be stronger and wider apart than in the figure there given.

The specimens sent by M. D'Eichwald are small pieces of—1. Light-grey soft marl, with "*Bairdia*[1] *Pyrrhæ*" and filmy valves of *E. Eos,* iridescent under the microscope. 2 and 3. Dark-grey hardish marl, having the surface-plane covered with delicate crumpled Estherian valves, minute and iridescent, chiefly *E. Eos;* a fragment of *E. exigua* occurs, lying with the others, on No. 2.

The little *Estheria* (figs. 22—24) from the Permian marls of Russia, has oblong valves, with the ends rounded (fig. 23, magn. 20 diam.); the posterior extremity rather more convex than the anterior; the ventral margin slightly curved; the dorsal line straight and long (equal to rather more than half the length of the valve), terminating anteriorly a little in advance of the umbo, which is forward and does not affect the outline of the valve. Concentric ridges about 15, delicate and distinct; the interspaces are neatly punctate with a minute reticular pattern (fig. 24, magn. 100 diam.).

It is difficult at first sight to find any exact correspondence between the above description of our little valves, and the description given in the 'Bullet. Moscou' and 'Lethæa Rossica,' of *Posidonomya Eos* and *P. exigua;* nor do our figures agree any better with the figures given by Kutorga and D'Eichwald. Taking in consideration, however, the difference of size of the individuals treated of here and in the works referred to, and the facts, that the coarse ridges and furrows of wrinkled individuals have been described as if they were of the same value as the delicate ridges and their neat interspaces,—that unless drawn with the *camera lucida* and a good microscope, the niceties of outline and ornament

[1] This is termed "Bairdia" by M. Eichwald; but I see no reason for referring it to that sub-genus. More probably, it is a *Cytheropsis.* (See further on, Appendix.)

are unattainable, I venture to disregard any apparent differences in figures and descriptions, and to look upon our figured specimen as a young form of *Estheria exigua*, Eichwald, sp. And I am confirmed in this view by receiving specimens of *E. exigua* and *E. Eos* associated on one piece of marl, as above stated.

The history of the species is as follows:—

A small Estherian fossil, from Kargala, near Orenburg, was described (under Bronn's name, *Posidonomya minuta*) by S. Kutorga, in 1844 (Zweiter Beitrag zur Palæontologie Russlands, in the 'Verhandl. d. R.-K. Mineral. Gesellsch. St. Petersburg,' Jahr 1844, pp. 63, 66, 86, pl. i, figs. 1—5), as occurring in a hard, ash- and black-grey shale (the laminæ sometimes ½ inch thick, sometimes very thin, and the planes of bedding streaked with copper-green), referred by Von Qualen to the lower group of the Zechstein-formation of the Government of Orenburg. Kutorga carefully indicates at p. 86, what appears to him to be points of difference between the Russian and the German (Bronn's) specimens. Remains of plants abound in this copper-shale; they were termed *Voltzia brevifolia* (Brongn.) by Kutorga, but D'Eichwald has subsequently referred them to *Ullmannia Bronnii*, Goepp., *U. Biarmica*, Eichw., and *Walchia lycopodioides*, Brongn.

In 1855 ('Lethæa Rossica,' livr., 4, p. 231), D'Eichwald described his *Posidonomya exigua*[1] as occurring in this cupriferous marl-shale of the neighbourhood of Kargala, in the district of Bjelebei, government of Orenburg. This little fossil he found associated with *Ullmannia;* and he regarded it as being probably a freshwater Mollusc. In the 'Bullet. Soc. Imp. Nat. de Moscou,' année 1856, vol. xxix, seconde partie, p. 559, M. D'Eichwald described *P. exigua*, as being very small, ovate, with the hinge-border lengthened backwards, the surface transversely wrinkled, with not more than eleven very fine punctured wrinkles. In 1859 ('Leth. Ross.,' livr. 6), after noticing the occurrence of a shell referred by him to "*Posidonomya minuta*, Goldf.," in shale of apparently Carboniferous age, near Izoume (Isjoum, 'Bullet. Moscou,' 1856, xxix, 2, p. 559), in the Government of Kharkoff (p. 940), and after remarking that most palæontologists still consider this little fossil to be a Mollusc, M. D'Eichwald described his *P. exigua* (p. 941, pl. 40, figs. 4 *a*, and 4 *b*), referring to Kutorga's previous account of it (see above), but suggesting that Kutorga's figure (fig. 5) of "*P. minuta* enlarged" may perhaps be a young *Unio umbonatus*. The following is D'Eichwald's description of *P. exigua:*

"Teste exigua, ovata, cardinali margine postrorsum prolongato, superficies sulcata transversis sulcis concentricis, 6 vel 11 nec pluribus, tenuiter punctatis:—In the copper-bearing sandstone of Kargala, Gov. Orenburg, associated with *Ullmannia Bronnii*.

"The little specimen figured (pl. 40, fig. 4 *a*, grand. nat. *b*, grossi) has the hinge-border straight, and the umbo scarcely projecting at the middle of the border, which, bent in a little arc, and obtuse at the two sides, is ordinarily prolonged equally before and behind; the furrows form little concentric striæ to the number of 6—11, very fine and

[1] Previously described in the Russian language in the 'Geogn. Russie,' 1846, p. 456.

sharp. The number of the concentric furrows is very variable; when there are only 6, they are deep, large, and removed one from another; when the number is double, they are straight and placed near together; it is then that the hinge-border becomes long and straight.

"The shell is so thin and delicate, that it bears many irregular depressions over all its surface. It is a little broader than long; the diameter is from 1 to 2 lines."

Kutorga observes (*loc. cit.*) that, in his specimens, there are 10—13 sharp, outstanding, concentric wrinkles; that the shell is very thin, and therefore seldom perfect, but occurring mostly as impressions.

M. D'Eichwald also figured and described in the same work (p. 942, pl. 37, fig. 13 *a*, 13 *b*), his *Posidonomya Eos*, previously termed by him *Cyclas Eos*, in the 'Geogn. de Russie,'[1] 1846, p. 466; and 'Bullet. Mosc.' 1856, xxix, 2, p. 575; and *Cytherina Eos*, 'Bullet Mosc.,' 1857, xxx, 2, p. 307. *C. Eos* is described as a very thin and friable little fossil, occurring in brownish-grey shale near Burakova, in the Government of Kazan; half a line broad, and a fourth of a line long, equally rounded on both margins, and marked with a little notch in front of the somewhat projecting umbo. In the 'Lethæa Ross.,' *Pos. Eos* is said to measure $1\frac{1}{2}$ line in one diameter, and nearly as much in the other, and is thus described.

"Testa minima, oblique ovata, vertice vix prominulo margini antico approximato, cardinali margine subalato, postice obtuso, superficies tenuiter transversim striata."

It seems to me quite possible that better materials might bear evidence of *E. exigua*, *E. Eos*, and *E. tenella*, (page 31) being all of one and the same species.

The nature of the habitat of *E. exigua* is obscure. *Cytheropsis Pyrrhæ* (see Appendix) may have been marine (according to what is known of its congeners), or otherwise.

5. Estheria Portlockii, *Jones*. Plate I, fig. 25.

Posidonia minuta, *Portlock*. Report Geology Londonderry, &c., 1843, p. 469.

$$\left.\begin{array}{l}\text{Height of valve, } \frac{2\frac{1}{4}}{12} \text{ inch} \\ \text{Length nearly... } \frac{3\frac{1}{3}}{12} \text{ ,,}\end{array}\right\}\text{Proportion 27 to 40, or } 1 : 1\tfrac{1}{2}\text{—}$$

It is with some doubt that I refer this unique fossil (a somewhat worn and imperfect concave impression) to *Estheria*. For certain it does not belong to *Estheria minuta*, which will be presently described. Still, it may be the cast of an *Estheria*, with which genus its outline and disposition of concentric wrinkles appear to be consonant. It is relatively large, but *E. striata* and others are larger. Its wrinkles are broad, but not too broad for an *Estheria* (see Pl. II, fig. 16).

This species (which I have named after its discoverer, one of the most eminent of the geological explorers of Ireland) appears to have been of a subovate form, narrowest behind; slightly curved on the ventral side, and straight on more than the central third of the dorsal edge; the umbo was a little in advance of the middle of the shell, the valve had

[1] Published in the Russian language.

about 12 concentric wrinkles, the interspaces being broad. (No ornament remains on the cast.) This is a unique specimen, in a matrix of fine-grained red sandstone, with micaceous bed-planes. It is in the Museum of Practical Geology, Jermyn street, and is labelled "Killyman, Co., Tyrone." It is referred to in J. E. Portlock's 'Report on the Geology of the County of Londonderry, and of parts of Tyrone and Fermanagh' (1843). In describing the locality where *Palæoniscus catopterus* (regarded by the author as belonging to the "Poikolitic" formation) was found, the following observations are made (pp. 468 and 469):

"This curious fish has been submitted to Professor Agassiz, and will very soon be published by him in the 'Fossil Fishes.'[1] It appears to have been in great abundance in one locality and in one layer of the red earthy sandstone of Rhone Hill, near Dungannon. The space occupied by the fishes was very small, being not more than a few square feet, and the specimens obtained entirely exhausted it; for, though an excavation was made of considerable extent, and carried carefully down to the level of the layer, and then below it, not a single additional specimen was discovered. Within that space they were crowded together, the surface of the layer being covered with them. The general size is 2·9″ long; but one which is more isolated is 3·75″ long and ·63″ deep. A small shell, *Posidonia minuta*, which, though not actually in the same layer, is found in the soft clayey seams which separate the adjacent layers, has been found in other localities [not in Ireland], but without any trace of the *Palæoniscus*. The only known localities [for this fish] is therefore Tyrone, Rhone Hill."

Other information respecting these red sandstones was given some years previously in a paper, by Sir R. I. Murchison, "On the Recent Discovery of Fossil Fishes (*Palæoniscus catopterus*, Agassiz) in the New Red Sandstone of Tyrone, Ireland," published in the 'Proceedings of the Geological Society,' vol. ii, p. 206, 1835.[2] It is here stated that—

"The quarry is at Rhone Hill, in the parish of Killyman, about three miles east of Dungannon. The New Red Sandstone in which it is excavated is a prolongation of the deposit which occupies large tracts in the county of Antrim, and extends into this part of Tyrone, where it surrounds a small, slightly productive coal-field, but reposes for the greater part upon Mountain-limestone....The beds of New Red Sandstone exposed in the quarry dip about 15° to the N.N.E., and consist, in the upper part, of red and green marls, passing down into a dark-red, thickly bedded, siliceous sandstone, with a few irregular, highly micaceous way-boards, of a deep-purple colour. The surface of some of the beds exhibits ripple-marks. The quarry (which is the property of Mr. Greer) is from 25 to 30 feet deep, and the fishes are found only in the bottom-beds, but are in great abundance."

[1] Ultimately described by Sir P. Egerton, in the 'Quarterly Journ. Geol. Soc.,' vol. vi, p. 4; and vol. xiv, p. 165, pl. 11, fig. 4.

[2] Also referred to in the 'Silurian System,' 1839, p. 43.

In both of the foregoing extracts this red sandstone is treated of as Triassic in age;[1] but of late years it has been referred to the Permian formation, as shown by the *Pal. catopterus* being termed "Permian" by Sir P. Egerton in the 'Quart. Jour. Geol. Soc.,' vol. vi, p. 9, and by Mr. Morris in his 'Catalogue of British Fossils,' 2nd edit., 1854, p. 336. Its geological place has not yet been determined by the geological surveyors, and for the present I prefer to regard it as of Permian age.

The stratigraphical position of the red marl and sandstone of Rhone Hill (Tyrone) is noticed at p. 481 of Portlock's 'Report Geol. Londonderry,' &c. The red marl is regarded as the same as that underlying the Chalk and Greensand at Benbradagh (Londonderry), and having a thickness there of between 600 and 700 feet, and overlying marls and sandstones, not less than 1000 feet thick, to which succeed the Carboniferous and Devonian strata.

6. Estheria minuta, *Alberti*, sp. Pl. I, figs. 28—30; Pl. II, figs. 1—7; Pl. V, figs. 8, 9.

Posidonia minuta, *Alberti*. *Von Dechen's* De la Beche's Handbuch der Geologie, 1832, p. 453.
— Goldfussii, *Alberti* (?). Ibid.
— Keuperiana [vel Keuperina], *Voltz*. Ibid.
— minuta (*Goldfuss*), *Alberti*. Jahrbuch f. Min., 1832, p. 227.
— — (*Alberti*), *Zieten*. Die Versteinerungen Württembergs, 1833, p. 72, pl. 54, fig. 5.
— — (*Goldfuss*), *Alberti*. Monographie, &c., 1834, pp. 114, 120, 121, 202.
— — *Goldfuss*. Petrefact. Germaniæ, pars ii, 1834-40, p. 118, pl. 113, fig. 5.
— — *Voltz*. Mém. Mus. Nat. Hist. Strasbourg, 1837, vol. ii, p. 7.
— Albertii, *Voltz*. Ibid.
Posidonomya minuta, *Bronn*. Leth. Geogn. (1835-38), vol. i, p. 164, pl. 11, fig. 22.
— — *Strickland* and *Murchison*. Transact. Geol. Soc., 1840, 2d ser., vol. v, p. 337, pl. 28, fig 4.
— — *Bronn*. Leth. Geogn., 3rd edit. (1851), vol. ii, part 3, p. 60, pl. 11, fig. 22.
Estheria minuta, *Rupert Jones*. Quart. Journ. Geol. Soc., vol. xii, p. 376.

From Sinsheim......	Height of valve... $\frac{1\frac{1}{3}}{12}$ inch	Length .... $\frac{1\frac{3}{4}}{12}$ "	Proportion 16 to 21, or 1 : $1\frac{1}{3}$—
" "	Height .... $\frac{1\frac{1}{2}}{12}$ "	Length .... $\frac{2\frac{1}{4}}{12}$ "	Proportion 18 to 27, or 1 : $1\frac{1}{2}$.
" "	Height, more than $\frac{1}{9}$ "	Length .... $\frac{1}{6}$ "	Proportion 1 to $1\frac{1}{2}$.
From Sulzbad, var. *Albertii*............	Height, less than $\frac{1}{10}$ "	Length .... $\frac{1}{6}$ "	Proportion 7 to 12, or 1 : $1\frac{3}{4}$—

[1] We must remember, however, that each of the terms "New Red Sandstone" and "Poikolitic" comprised, until about 1841, both the "Upper Red Sandstone" and the "Lower Red Sandstone," the latter of which was then divided off, with the magnesian limestone, under Murchison's term "Permian."

Carapace convex, compressed-oviform, like a *Pisidium*.[1] Carapace-valves more or less oblong, with rounded corners, or subovate; varying in outline from subquadrate (Pl. I, fig. 28) to irregular ovate (Pl. II, fig. 1). The hinge-border is straight, but varies somewhat in relative length, sometimes falling away quickly into the curve of the posterior border (as in Pl. II, fig. 4), sometimes equal to two thirds the length of the valve; the umbo is placed forwards, at the end of the hinge-border, and the anterior margin curves away in front of it, with a bold, semicircular outline. The ventral border is more or less convex, usually symmetrical, but sometimes oblique (Pl. II, figs. 1 and 5), trending upwards posteriorly; the hinder margin is rounded, like the anterior, but it is longer, more contracted, and less obtuse, giving an obliquely ovate outline to the valve, which is highest anteriorly, whilst in *E. striata*, *E. Mangaliensis*, and *E. Murchisoniæ*, it is highest posteriorly. Figs. 2 and 6, Pl. II, show the lateral convexity of the carapace to be greatest just behind and below the umbo, in the anterior third of the shell. Between the concentric ridges (which are about 14 in number and upwards), the carapace bears a reticulate ornament[2] of irregularly hexagonal meshes, 5 to 7 of which may be traced from ridge to ridge; the size of the meshes and the thickness of their walls varying very much in different specimens (Pl. I, fig. 30, and Pl. II, figs. 3 and 7), according to the degree of fossilization and wear, for the most part.

The best specimens which have afforded me exact information as to the form, structure, and features of the carapace of *Estheria minuta* are from Pendock, Worcestershire (Pl. II, figs. 1—3); all others that I have seen have suffered so much from pressure and from loss or modification of the shell-substance that the evidence they afford of the original conditions of the carapace is very obscure. A variety of *E. minuta* occurs also in the beds between the Trias and the Lias (Rhætic) of England and Scotland; and carapaces of this variety occur in excellent preservation in some localities (Pl. II, figs. 9—15).

To understand rightly the exact relationship of the Triassic and Rhætic *Estheriæ* of Britain to *Estheria minuta* of the Trias of the Continent, we must first take the latter in hand, and work out its characters, geological position, and bibliography.

The chief specimens of the German *Estheria minuta* that I have examined have come from the south-western portion of the Triassic area of Baden, Würtemberg, and Bavaria, through the kindness of F. von Alberti, Sandberger, Bronn, Krantz, Hassencamp, and others. From the Thuringian and Hanoverian Triassic areas, in some parts of which *E. minuta* has been described as occurring abundantly, I have only one (Thuringian) specimen. Of French specimens, from the Trias of the Vosges (Alsace), I have some from Soultz-les-Bains, communicated by Dr. Schimper.

My German specimens are—

[1] Resembling in general appearance several of the recent *Estheriæ*,—such as those figured in pl. 11 (*Annulosa*) of the 'Proc. Zool. Soc.,' 1849.

[2] Very similar to that of the recent *E. Dahalacensis*, Durckh., from the freshwater marshes of the Island of Dahalac, Abyssinia. (Baird, 'Proc. Zool. Soc.,' 1849, p. 89, *Annulosa*, pl. 17, fig. 2.)

1. From the Muschelkalk (or rather the Lettenkohle-group) on the Prim, near *Rothenmünster*, not far from *Rottweil*, about 50 miles south of Stuttgart. A dark-grey, hard, argillaceous, thin-bedded rock, very slightly calcareous, weathering ochreous; casts of *Estheria minuta* (varying from $\frac{2}{12}$ inch to $\frac{1}{12}$ and less in length) on the plane of bedding. From Mr. F. von Alberti, of Friedrichshall.

2. From *Haigerloch*, in Swabia (Hohenzollern), 32 miles S.S.W. of Stuttgart, and 44 miles S.E. of Strasburg. Light-brown and fine-grained limestone (weathering grey), from the dolomitic beds of the Lettenkohle formation, between the Muschelkalk and the Keuper. The specimens (casts of apparently double valves) are in the mass of the specimen, and are but few. From Dr. Krantz, of Bonn.

3. From *Sinsheim*, in Baden, on the Elsenz, 23 miles S.S.E. of Mannheim. Brown, fine-grained, gingerbread-looking, dolomitic (?) limestone. The *Estheriæ* (casts of double valves) lying crowded on two planes of bedding, which are half an inch apart. Fragments of *Myalina* (?) accompany the *Estheriæ* on one of the specimens. These are marked "Keuper-Mergel," and were given to me by Dr. Krantz.

4. From Heilbronn, on the River Neckar, in Würtemberg, 36 miles north of Stuttgart. Yellowish-grey, fine-grained, argillaceous stone, hard and heavy, and finely micaceous. *Estheriæ* numerous in casts on the surface-planes, together with *Lingula tenuissima* in equally large numbers, and a cast of the two valves of a *Pleurophorus*. Belonging to the "Lowest beds of the Keuper-Mergel." Two specimens, from Sir C. Lyell.

Another specimen, very similar, but with the *Lingulæ* in better condition, and the Estheria-casts less flattened, from MM. Engelhardt and Schimper, marked "Dolomie supérieur du Muschelkalk."

These specimens afford crushed carapaces and often shell-less casts, which are wrinkled, rather than ridged, concentrically, and they rarely afford a clear trace of the distinctive reticulate sculpture (Pl. I, fig. 30).

5. Light-brown, laminated, sandy clay, with numerous delicate casts of *Estheriæ*, of different sizes,[1] on a bed-plane. From the Lettenkohlenschiefer (shales of the Lettenkohle), near Weyhers, Bavaria. This was kindly sent to me in February, 1862, by Herr E. Hassencamp, of Weyhers (Franconia), Bavaria, in fulfilment of a wish expressed, in the 'Neues Jahrbuch,' 1861, Heft 7,[2] p. 834, that I might be favoured with specimens of *Estheriæ* by Continental geologists.

Mr. Hassencamp informs me that the *Estheria minuta* occurs in the West Rhön—

(1) In the Lettenkohlenschiefer near Weyhers and Fulda, as well as in the dolomite belonging to the latter, also containing *Lingula tenuissima*.

[1] These are all small, varying from $\frac{1\frac{1}{2}}{12}$ to $\frac{1}{12}$ inch and less in length.

[2] A provisional list of the species of *Estheriæ* that I had met with in November, 1861, appears in this number of the 'Neues Jahrbuch;' considerable alterations, however, in the list have since been made, as are shown in this monograph.

(2) In the uppermost beds of the Muschelkalk, with *Lingula tenuissima,* near Weyhers.

(3) In the Bunter ("Rothe"), just under the lowest bed of the Muschelkalk, on the Eube, near Gersfeld.

6. From near Halle, on the Saale (Thuringia).

Greenish-grey, micaceous shale. The *Estheriæ,* large and small,[1] occur on the bed-planes; these have preserved their shape, but retain only a dull, thin, pulverulent film of the carapace. Labelled "Uppermost Buntsandstein." From Prof. Fridolin Sandberger, of Carlsruhe.

Prof. Fr. Sandberger informs me, through Dr. H. G. Bronn (who kindly communicated to me the specimens from Prof. Sandberger and Mr. von Alberti), that he has met with this *Estheria* at Durlach, near Carlsruhe (Baden), in the Muschelkalk just above the Wellenkalk; also in the Lettenkohle of Nimburg, near Bottingen, in the Breisgau.

Estheria minuta in Baden, Würtemberg, and Bavaria.—This little fossil has been known to geologists for about thirty years as characteristic of the Upper Trias of Germany, attention having been drawn to it by F. von Alberti; and Voltz seems to have recognised it as an important fossil of the Keuper about the same time. It was referred to the molluscan genus *Posidonia* (subsequently *Posidonomya,* Bronn). Alberti and Goldfuss seem to have coincided in terming it *P. minuta,* for the former refers to the latter (in 1832,[2] and again in 1834,[3] when he described the species) as the authority for this name, although he used it before Goldfuss had published his description and figure. Von Dechen (1832) and Zieten 1833) refer to Alberti as the giver of the name, and in this I propose to follow them.

1832. In H. von Dechen's German edition of De la Beche's 'Handbook of Geology,' (H. T. de la Beche's 'Handbuch der Geologie, bearbeitet von H. von Dechen,' Berlin, 1832), p. 453, we find the earliest published specific name for this little fossil. Thus:—
"*Posidonia Keuperiana,* Voltz (*P. Goldfussii,* Von Alberti?), Swabian Hall,[4] Lower Beds.
——— *minuta,* Von Alberti, Rottweil."[5]

1833. In C. H. von Zieten's 'Die Versteinerungen Württemberg's, 1830-33, we have, at page 72—

"*Posidonia minuta,* Alberti, De la Beche, bearbeitet von Dechen, Berlin, 1832, p. 453. From the copper-marl of Rottweil." This is figured in Zieten's pl. 54 fig. 5.

1834. In 1834, F. von Alberti, in his 'Beitrag zu einer Monographie des Bunten Sandsteins, Muschelkalks und Keupers, und die Verbindung dieser Gebilde zu einer

[1] Varying in length from $\frac{2\frac{1}{2}}{12}$ to $\frac{1}{16}$ inch.

[2] 'Jahrb. f. Min.,' 1832, p. 227.

[3] 'Monographie,' p. 114.

[4] In Würtemberg, on the Kocher, thirty-five miles north-east of Stuttgart. The name here attributed to Voltz does not appear to have been given in connection with any description.

[5] In Würtemberg, about fifty miles south of Stuttgart.

Formation,' published full particulars as to the occurrence of the so-called POSIDONIA MINUTA in certain beds of the Trias.

The Triassic striata of the Würtemberg district he grouped thus:

- Keuper[1] (900—1000 feet.)
  - Keuper-Sandstein, or variegated marls with sandstone. (Including the so-called bone-bed of the Lias.)
  - Keuper-Gyps, or variegated marls with gypsum. (Including a Reptiliferous breccia.)
  - Lettenkohlengruppe
    - Gypsum.
    - Limestone.
    - Dolomite (50 feet).
    - Sandstone.
    - Marl-slate (*Estheria*).
    - Lettenkohle[2] (1—12 inches).
    - Shale and sandstone (*Estheria*).
- Muschelkalk (700—1030 feet)
  - Limestone of Friedrichshall (150—400 feet).
  - Anhydrite-group (350—400 feet).
  - Wellenkalk (200—240 feet).
- Bunter Sandstein (600—800 feet).

At pp. 114, 119, and 120, of Alberti's 'Monographie,' he says—"Above the dolomite of the Muschelkalk, and below the Lettenkohle (Coal-shale), are clay-beds and shales, which pass more or less into sandy shale, and sometimes into sandstone, and then they become very micaceous. In these strata occur *Equisetum arenaceum*, Bronn, *Tæniopteris vittata*, var. *major*, Brongn., and Fucoidal bodies; also Reptilian remains (*Mastodonsaurus*), *Gyrolepis tenuistriatus*, Ag., *Hybodus sublævis*, Ag., and *Posidonia minuta*, Goldfuss.

"P. MINUTA, *Goldf.*, is square-oval, with 9 or 10 concentric ribs, of the size of a flax-seed; like *P. Becheri* (Bronn) from the Grauwacke, and the *P. Bronni* (Goldf.) of the Lias, but smaller and thinner. It is figured in Von Ziethen's 'Verst. Würt.,' pl. 54, fig. 5. It occurs at the Primthal,[3] near Rottweil (about fifty miles south of Stuttgart), in the Bore-hole No. 3, near Schweningen."

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[1] A detailed section of the Keuper, as seen near Stuttgart, is given in the 'Silurian System,' p. 30; and a careful comparison of the English German, and French Triassic beds will be found in the same chapter.

[2] In his 'Steinkohlenformation in Sachsen,' p. 4, Geinitz says—"The Lettenkohle (Shale-coal or Keuper-coal) is described by Voigt, in his 'Versuche einer Geschichte der Steinkohlen, der Braunkohlen und des Torfes,' as the generally impure, argillaceous, and pyritous coal-beds of the Keuper, lying on the Muschelkalk, and met with on the Schösserberg, near Mattstedt in the Grand-Duchy of Weimar, and at some other places in Thuringia, in France, in Saxony, on the bank of the Main, near Schweinfurt in Swabia, and in Lothringen. It is of little value as a fuel, even for lime-burning and furnaces, and is chiefly used for the manufacture of alum and vitriol. The organic remains of the Lettenkohle-group have been described in a monograph by J. G. Bornemann, in 1856."

[3] A specimen from the valley of the Prim is referred to above (p. 44), as having been kindly presented to me of late by the veteran geologist Von Alberti.

At pp. 113 and 114, we have the following section of the beds in which P. MINUTA occurs, in descending order:

	Feet.
Dolomitic rocks of the gypsum-group.	
Greenish-grey marl-slate	1
Yellowish-grey, dolomitic, marly beds, with some impressions of Plants, *Lingula tenuissima*, and *Posidonia minuta*	2¾
Grey dolomite	½
Dolomite, with indistinct Shell-remains	1
Aluminous sandy shale, with indistinct Plant-remains, carbonaceous patches, and much mica. Equivalent to the sandstone of the Lettenkohle-group	4¾
Dolomite	¾
Dark, ash-grey, somewhat sandy shale, with calcareous and sandy nodules	1
Grey dolomite	1
Blackish-brown, sandy, and micaceous marl-slate, full of carbonaceous patches, and with remains of Fishes and Reptiles. Equivalent to the Lettenkohle	5½
Ochre-yellow, dolomitic marl	3¾
Ash-grey, shaly clay, with fragmentary shells	7½
Yellowish-grey dolomite.	

This section was taken from the shaft above the Bore-hole No. 3, near Rottenmünster, and from the neighbouring bank of the Prim.

At pp. 116 and 117, the section of the "Posidonia-marls," near Rietheim, is given thus:—"Above Rietheim, near Hall,[1] there are on the Muschelkalk a few inches of dolomite, full of remains of Reptiles and Fishes, then the Lettenkohlensandstein.

"In the quarries between Rietheim and Bieberfeld the sandstone (Lettenkohlensandstein) is thirty to thirty-five feet thick, in beds of as much as three and a half feet thick. It contains a quantity of Reptilian and Fish remains, and fine impressions of Plants; thereon lie sandy marls, passing into shaly sandstone, and containing many Plant-impressions; light-grey in colour, passing into yellowish-grey (eight to ten feet thick); yellow and grey marl, harder downwards, and dividing itself into beds of five or six inches thick, rich in *Posidoniæ*. Above that come variegated marls. Above the Posidonia-marls appear here and there the Lettenkohle, then again yellow, and lastly variegated marls."

At p. 121, he adds:—"The Mergelschiefer [marl-shale] above the Lettenkohle is of grey, yellow, or green colour, and often passes into shale, sandstone, or dolomite. It contains Reptilian remains, Fish remains (*Acrodus* or *Hybodus*), and Plants (*Equisetum arenaceum*,[2] Bronn, *Tæniopteris vittata*, var. *major*, Brongn., *Pterophyllum longifolium*, Brongn.), also *Posidonia minuta*, *Lingula tenuissima*,[3] and a bivalve like *Sanguinolaria* in form.

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[1] In Würtemberg, thirty-five miles north east of Stuttgart.

[2] This is the *Equisetites Bronni*, Sternberg, and the *Calamites arenaceus minor*, Jaeger.

[3] According to Alberti, op. cit., p. 318, *Lingula tenuissima*, Bronn, occurs in the Dolomite, the Lettenkohlengruppe, in the Muschelkalk, and in the Bunter Sandstone. It occurs, according to Bornemann ('Org. Reste Lettenkohl.,' 1856), rarely in the Myacites-clay of the Lettenkohle-group, but more abundantly in certain of the passage-beds between that group and the Muschelkalk. Having examined several specimens of Triassic rocks containing *Lingulæ*, namely, those already mentioned (p. 44), and some others kindly lent me by M. Engelhardt, of Niederbronn, and Dr. Schimper, of Stuttgart, I have noticed

At p. 202, Von Alberti mentions the occurrence of ***Posidonia minuta*** in red standstone (Bunter Sandstein), together with Plant-remains, near Sulzbad (Bas-Rhin), and Corcelles (Haute Saône); also ***Lingula tenuissima*** at Sulzbad and Douptail. (These and other fossils, many undetermined and undeterminable, were seen by Alberti in the Museum of Strasburg, in 1831.)

At p. 320, it is stated that ***Psammodus Elytra, Avicula subcostata, Posidonia minuta***, and ***Equisetum arenaceum*** occur both in the Bunter Sandstone[1] and in the Keuper.

1834-40. In A. Goldfuss's 'Petrefacta Germaniæ,' Zweiter Theil. (1834-40), p. 118, the following occurs:

"*Posidonia minuta*, nobis, Pl. 113, fig. 5. Posidonia testâ minutâ, transversim ovato-rotundâ, planâ, inauriculatâ, costis majoribus concentricis (8-10) minoribusque marginalibus confertis. Zieten, *l. c.*, pl. 54, fig. 5. These small shells occur bed-like in the Keuper, especially at Hassfurth[2] (not far from Schweinfurth),[3] near Heilbronn,[4] and at Pforzheim.[5] Usually there is only the impression of the outer surface, rarely the remains of the extremely thin shell. The shell is flat, obliquely roundish oval, and has 8-10 convex, regular, concentric wrinkles. In the lower third these become smaller, and lie closer together. There are no ear-like processes."

1843. In giving an account of the Triassic beds of Würtemberg, 1843 ('Das Flözgebirge Würtemberg's,'[6] p. 541, &c.), F. A. Quenstedt separates the Lettenkohle-group from the lower part of the Keuper, and ranks it as the upper member of the Muschelkalk. Hence some authors refer to *Estheria minuta* as belonging to the Keuper, after Alberti's classification; whilst others speak of it as being lower in the scale, either as occurring in the Upper Muschelkalk or between that and the Keuper, according to their views as to the relations of the Lettenkohle for this is regarded by some as being distinct from both the Upper Muschelkalk and the Keuper. Quenstedt's classification is shown in the following table:

that in the Grès Bigarré, of Sulzbad, there is a ***Lingula*** three fourths of an inch long, and three eighths wide; that in the hard, dark-grey shale of the Wellenkalk of Horger, Würtemberg, there is a ***Lingula*** half an inch long, and three eighths wide; that in the dolomitic marlstone of the Lettenkohle of Durlach, Baden, the ***Lingulæ*** are one fourth of an inch long; and lastly, that in the Estherian marlstone, near Heilbronn, the ***Lingulæ*** are only three sixteenths of an inch in length. This gradual dwarfing of the ***Lingulæ*** (in the ratio of six, four, two, and one a half), as we rise in the series towards the Keuper, indicates the gradually increasing influence of some agency unfavorable to the growth of these Brachiopods, such, perhaps, as a larger and larger influx of fresh water into their habitat, until the water became sufficiently free from salt to allow of the presence of ***Estheriæ***, whilst the ***Lingula tenuissima*** still survived.

[1] ***P. minuta*** is not mentioned amongst the fossils of the German Bunter Sandstone, at p. 39, but it is at p. 202, as found at Sulzbad.

[2] In Bavaria, on the River Main, thirty-four miles north-east of Wurzburg.

[3] In Bavaria, on the right bank of the River Main, twenty-four miles north-north-east of Wurzburg.

[4] In Würtemberg, on the River Neckar, twenty-miles north of Stuttgart, twenty-six miles south-east of Heidelberg.

[5] In Baden, at the confluence of the Enz and the Nagold, fifteen miles south-east of Carlsruhe.

[6] Tübingen, 8vo, 1843.

Keuper	*e.*	Yellow, hard sandstone, with Bone-bed. *Modiola minuta, Avicula gracilis,* and *Myacites.* Patches of coal.
		Red clays.
	d.	White sandstone, alternated with bright-coloured and blue clays; coal-patches; silex and agate. Reptilian bones.
	c.	Variegated marl and sandstone, with foot-tracks and ripple-marks. Shells rare.
	b.	Green and reddish sandstone. Plants.
	a.	Gypsum and marls. Shells. Reptiles. *Ceratodus.*
Muschelkalk	*d.* Lettenkohle	Dolomitic limestones. *Estheria minuta, Lingula tenuissima, Trigonia Goldfussii, Gervillia socialis.* Fishes.
		Marl and clay. *Mastodontosaurus.*
		Grey sandstone, with *Equisetites*
	c. Muschelkalk proper	Grey sandstone, with Bone-bed. *Coprolites, Gryolepis tenui-striatus, Acrodus Gaillardoti, Psammodus, Hybodus plicatilis, Dracosaurus Bronnii.*
		Dolomite, and limestone. *Pemphyx Sueurii, Fucus Hehlii.*
		Thin marly limestones. Saurian and Fish-remains, *Ceratites nodosus, Encrinites liliiformis,* and abundance of marine shells.
		Limestones.
	b. Salt-group	Limestone.
		Clays with gypsum and rock-salt.
		Limestone.
	a. Wellenkalk	Wellenkalk } Marine shells, &c.
		Wellendolomit } Marine shells, &c.
Bunter	*b.* Red sandstones.	
	a. Sandstone.	

Quenstedt thus refers to *Estheria minuta* and *Lingula tenuissima* of the Keuper, in his 'Flözgebirge Würtembergs,' pp. 71 and 75. "Above the Lettenkohle (he says) is an extremely hard dolomite, several feet thick, lying between thin dolomitic beds, darkish in colour, and streaked with yellow. Careful search in the thin dolomites overlying the hard variegated dolomite, may be made with interest, for at every splitting of the beds the little *Posidonia minuta* scales off in thousands; and in some specimens a thin-shelled *Lingula* occurs, which in this association, although without any very striking characteristic of its own, becomes the strongest boundary-mark for the Muschelkalk formation. This fine-striped *Lingula,* called *tenuissima,* on account of the thinness of its shell, is distinguished only by its place of occurrence from the *Lingulæ* of other formations. It lies always above the sandstone and variegated dolomite (Flammendolomit), and scattered among the *Posidoniæ. P. minuta* is seldom many lines in diameter, it has an obliquely oval shell with a straight hinge, and is only on account of its concentric wrinkles recognised as a *Posidonia.* The specimens might be taken for badly preserved *Astartes,* or many other shells; so little is known of its generic characters."

Again, in his 'Handbuch der Petrefaktenkunde,' Tübingen, 1852, p. 516, Quenstedt says—"*Posidonomya minuta* (pl. 42, fig. 13; 'Zieten. Verst.,' pl. 54, fig. 5) lies in millions in the dolomitic beds above the Lettenkohle. This little longish shell may as well belong to an *Astarte,* or any other bivalve. From the impressions this cannot be decided."

1851. From H. G. Bronn's third edition of his 'Lethæa Geognostica,' 1851, vol. ii,

part 3, p. 60, after a list of synonyms, of which we have availed ourselves (with some slight corrections), *Posidonomya minuta* is stated to occur in the following localities.

Rarely in the Bunter Sandstone, with plants, at Sulzbad and Corcelles; also in the uppermost part of the Muschelkalk (ζ), near Biberfeld in Würtemberg; more plentiful in the Lettenkohlen-Gruppe (κ) of Würtemberg on the Schwarzwald, near Rottweil, at Rottenmünster, and elsewhere (ο, ρ, Alberti, τ Quenstedt); also at Pforzheim and at Sinsheim, near Heidelberg; in the uppermost layers of the Keuper Sandstone (εε) in Würtemberg (Täbingen); and, as it appears, still higher, increasing in size (to 7‴ long). Lastly, at Hassfurth, near Schweinfurth (Goldfuss), and in the Keuper, near Weimar; in the Upper Keuper, at Elliehausen, near Göttingen, and in the Upper Bunter Sandstone, near Dassel, in the Solling. *Posidonia Keuperina* has been recorded from the Lower Keuper beds at Hall, in Swabia, and is probably identical.

On the other hand, adds Bronn, the occurrence of the true *P. minuta* in the Russian Copper-sandstone (Kutorga, in Jahrb., 1844, p. 742, and his Zweit. Beitrag zur Paläontol. Russl., 1844, p. 14, pl. 1, fig. 4 (Comp. Jahrb., 1849, p. 754), and in the Keuper of the Venetian Alps (Catullo in 'N. Ann. Scienz. di Bologna,' 1846, Febbr.), is very doubtful.

Thuringia.—The published notes on the occurrence of *Estheria minuta* in the Thuringian Trias are as follow:

1849. Herbst ('Neues Jahrbuch, f. Min.,' 1849, p. 545) refers to *P. minuta* being met with in the Keuper of Weimar.

1856. Dr. J. G. Bornemann has treated of *Posidonia minuta* in his work 'Ueber organische Reste der Lettenkohlengruppe Thüringens,' 4to, Leipsic, 1856, p. 179, and figures it (indifferently) in his plate 1, fig. 9. It occurs, he says, at Johannisthal, near Mühlhausen, and elsewhere, in great numbers on the surface-planes of the Myacites-clays of the Letten-coal group, associated with *Trigonia transversa*,[1] Bornem., and *Myacites letticus*, Bornem., and in a similar state of preservation; and also in the black-grey shales which accompany the Lettenkohle, but in bad preservation. It reaches generally to about three millemetres in length. *Venus donacina*, Goldf., and *Lingula tenuissima*, Bronn, with remains of *Acrodus Gaillardoti*, Ag., and teeth of *Placodus* also occur in the Myacites-clays.

1857. In a paper on the Entomostraca of the Trias of Thuringia, in the 'Zeitschrift deutsch. geol. Gesellschaft,' vol. ix, p. 198 (1857), K. von Seebach mentions the occurrence of *Posidonomya minuta*, Bronn, in marls, immediately underlying the Lettenkohle of the Keuper, at the Gelmerodaer Berg and elsewhere, near Weimar, where it is accompanied with *Acrodus Gaillardoti*, Ag., *Colobodus varius*, Gieb., Plant-remains, *Myophoria transversa*, *Myacites*, *Cythere*[2] *Pyrus*, Seeb., *C. procera*, Seeb., *C. teres*, Seeb., and *C. dispar*, Seeb.

[1] This is the *Lyriodon vulgare*, Goldfuss, 'Petref. Germ.,' ii, p. 198, pl. 135, fig. 16, *c*.

[2] Von Seebach terms the first three of these Entomostraca *Bairdiæ*, but to me they do not appear to belong to that subgenus.

In the marls of the Muschelkalk of the same district, von Seebach also found *P. minuta*, with *Gervillia socialis*, Wism., *Colobodus varius*, Gieb., and casts of *Cytheres*.

Hanover. Dr. Volger, of Göttingen, mentions in the 'Neues Jahrbuch f. Min.,' 1846, p. 818, the occurrence of *Posidonomya minuta* in the neighbourhood of Göttingen, at Ellichausen, in the Upper Keuper, and near Abbecke in the Solling, not far from Dassel,[1] in the Upper Bunter Sandstone (laminated sandstone, alternating with marl-beds), in great numbers; and he suggests, "may it not be a bivalved Crustacean?"

In 1860. Baron von Strombeck, of Brunswick, described the position of the beds containing *Estheria minuta*, near Salzgitter, Hanover, in his paper[2] on the Myophoria-beds, published in the 'Zeitschrift der deutsch. geol. Gesellschaft,' vol. xii. From information derived from Herr Schloenback, the following series of beds is said to be observed at the foot of the Greif and at the Salgenteich, near Salzgitter[3] (p. 387).

Variegated Keuper-marl.
Lettenkohle, 1 inch.
Greyish-yellow, micaceous, and argillaceous sandstone, alternating with dark-blue laminated clay. *Myophoria pes-anseris*, *M. transversa*, *Lingula tenuissima*, and *Posidonomya minuta*.
Reddish-brown clay; in its upper part a limestone (2 feet thick), containing *Myophoria Struckmanni*, *M. pes-anseris*, and *Ammonites* (*Ceratites*) *nodosus*: 20 to 50 feet.
Muschelkalk.

Close to Lüneberg,[4] at, and near the Schafweide, the section appears to be from von Strombeck's account (p. 381, &c.)—

Variegated Keuper-marl.
Laminated clay (with *Lingula tenuissima*), alternating with thin beds of limestone, full of pseudomorphic salt-crystals.
Dolomitic beds,[5] with *Myophoria pes-anseris* and *Ammonites nodosus*.
Dark greenish-blue clay: 100 feet.

[1] In the valley of the Sollen, twenty-three miles north-north-west of Göttingen.

[2] 'Ueber die Trias-Schichten mit *Myophoria pes-anseris*, Schlot., auf der Schafweide zu Lüneburg.'

[3] See the geological map of this district, in 'Karsten's Archiv,' xxvi, pl. 1.

[4] For a map, see 'Zeitsch. deutsch. geol. Gesell.,' 1853, vol. v, pl. 11.

[5] Belonging, according to the author, to the Lettenkohle-group, and not to the Upper Muschelkalk. See also Von Strombeck's paper 'Ueber das Vorkommen von *Myophoria* (*Trigonia*, *Lyriodon*) *pes-anseris*, Schlot., sp.' 'Zeitsch. d. deutsch. geol. Ges.,' 1858, vol. x, p. 80, &c. In this memoir (p. 86), *Posidonomya minuta* is said to occur here and there in the Myophoria-beds, but not abundantly, in company with *Myophoriæ*, *Myacites letticus*, *Gervillia socialis*, *Pecten Albertii*, *Lingula tenuissima*, &c. The last mentioned is figured in Bronn's 'Lethæa Geognost.,' vol. ii, part 3, p. 51, pl. 13, fig. 6. At Lüneburg, it has not so sharp an umbo as in Bronn's figure. It occurs plentifully on the surface-planes of the shales, and occasionally in the other beds, and always preserves its brownish thin shell (contrasting

Estheria minuta in France (*Alsace*).

In the 'Jahrbuch für Mineral.' &c., 1832, p. 227, F. von Alberti says :—" A year ago I was in Strasburg, and I saw in the museum there *Lingula tenuissima, Posidonia minuta,* Goldf. (*P. Keuperina,* Voltz ?), *Avicula subcostata,* Goldf., and *Calamites arenaceus,* Brongn., from the Bunter Sandstone of the neighbourhood of Sulzbad.[1]

In the 'Mém. Soc. Hist. Nat. Strasbourg,' 1837, vol. ii (see also the 'Jahrb. f. Min.,' 1838, p. 340), Voltz mentions the occurrence of the following fossils in the Middle Bunter Sandstone[2] of Soultz-les-Bains. Saurian remains (*Odontosaurus Voltzii,* Meyer, &c.), Crustaceans (*Gebia? obscura,* Mey., *Galathea audax,* Mey.), *Pecten discites,* Schl., *Posidonia minuta,* Bronn, *P. Albertii,*[3] Voltz, *Mya ventricosa,* Schl., and abundant Plant-remains.[4]

I have seen some French specimens of *Estheria minuta,* by the kindness of Professor W. P. Schimper, and his friend M. Engelhardt, of Niederbronn.

1. From *Corcelles* (*Haute Saône*). From the Lettenkohle, "*Estheria Keuperiana,* Voltz," on the bed-planes of black laminated lignite; the shell flattened, slightly wrinkled, retaining its ridges and interspaces (best seen on some impressions), and changed into a white siliceous (?) substance, with faint traces of structure. From MM. Engelhart and Schimper.

2. From *Oberbronn* (*Bas-Rhin*). Brown dolomite, like that of Sinsheim and Haigerloch, weathering ochreous ("Marnes dolomitiques du Muschelkalk, Lettenkohlegruppe). Scattered casts (chiefly of the closed carapace); some bare, some with a whitish film of shell. From Dr. W. P. Schimper.

3. From *Soulz-les-Bains* (*Bas-Rhin*). In greenish grey and yellowish-grey shale, more or less micaceous. From Dr. W. P. Schimper, of Strasbourg. These *Estheriæ,* occurring on the planes of bedding, and mostly crushed, appear in some instances to have

with the casts and impressions of the other fossils). It is peculiar to the Lettenkohle-group according to von Strombeck (p. 86); but Bronn seems to give it a larger range ('Leth. Geog.' ii, p. 51). See also above, p. 47.

[1] Soultz-les-Bains (also Soultz-à-Bains and Sulzbad), in France (Dép. du Bas-Rhin), about twelve miles west of Strasbourg. For the geological features of this place and its vicinity, see A. Daubrée's 'Description Géologique et Minéralogique du Département du Bas-Rhin,' 8vo, 1852, with map and sections. Hogard's 'Descript. Minéral. et Geol. des Regions Gran. et Arén. Syst. des Vosges,' 1837, treats of this locality, and gives geological sketches and sections of the neighbourhood. Voltz also described the geology of the Vosges in the 'Mém. Soc. Hist. Nat. Strasbourg,' 1837, vol. ii.

[2] The Upper Bunter Sandstone of Sulzbad is stated by Voltz to contain fossils of the Muschelkalk, without Plant-remains. Voltz's Lower Bunter Sandstone is now known as the Vosges Sandstone (Grès de Vosges), probably of Permian age.

[3] The particular distribution of these fossils in their strata can be better followed by a study of M. Daubrée's 'Descript. Géol. Bas-Rhin,' 1852, p. 116, &c.

[4] *P. Albertii* is described by Voltz, in a foot-note, at p. 7 of his memoir, as having the ventral border sinuous, and being longer than the *P. minuta,* but quite as small. This appears, however, to have been a variety, or a distorted individual.

a somewhat narrower outline than is usual with *E. minuta.* See Pl. V, fig. 9. This may be the form indicated by Voltz as *Pos. Albertii ;* if so we may distinguish it as *E. minuta,* var. *Albertii.*

The occurrence of *Estheria minuta* at two horizons in the Triassic Series of the Lower Rhine, is clearly indicated by Prof. A. Daubrée in his admirable 'Description Géologique &c. du Departement de Bas-Rhin,' 1852.

M. Daubrée has courteously replied to my inquiries respecting the Estherian strata of Alsace, and put me in communication with Prof. W. P. Schimper, who has obligingly favoured me with specimens and information.

In the district referred to, the Triassic strata, underlying the "Lias Sandstone with bones of Reptiles and Fishes," are thus enumerated :

Keuper. (At Oberbronn,[1] 'Géol. Bas-Rhin,' p. 127).	Marls and dolomites, alternating (four mètres) ; among them is a dolomitic marl containing impressions of bivalve shells (*Estheria minuta* and *Lingula tenuissima*). Blackish marls and blackish micaceous schists, with carbonaceous remains of plants : four or five mètres. Red and grey marls and dolomites, with some sandy beds. Yellowish micaceous sandstone and dolomite, with undeterminable casts of bivalves.	
Muschelkalk. (Alsace ; *Op. cit.*, p. 118, 119.)	Dolomites, interstratified with marls. Fossiliferous limestone, with marly partings. Dolomites. (Wellenkalk.)	
West of the Vosges, at Saltzbronn ; *Op. cit.*, p. 120.	Red and green clays, with gypsum and rock-salt.	
At Soultz-les-Bains ; *Op. cit.*, p. 102.	Passage-beds of the Muschelkalk. Beds of crystalline dolomite, with thin bands of shale.	
Grès Bigarré or Bunter Sandstone. (*Loc. cit.*) Upper.	Sandstone, in bands from eight to twenty inches thick, alternating with laminated clays and dolomites (each in bands from four to eight inches thick), forming a yellowish and reddish series of fine-grained sands and clays.	About fifty feet.
Grès Bigarré or Bunter Sandstone. (*Loc. cit.*) Lower.	Fine-grained sandstones, reddish, yellowish-brown, and greenish grey (redder below, greyer above), with ferruginous streaks, in beds of from twenty inches to eight feet thick, separated by thin beds of laminated sandstone and shaly clay. *Estheriæ.*	About forty feet.

Passage-bed. Red pebbly sandstone.
Vosges sandstone (= Permian).

"In the quarry at Soultz-les-Bains, which has been the most productive, the beds lying over the sandstones worked for building-stone, contain very few remains of plants, but

[1] Two miles south-west of Niederbronn, and seventeen miles and a quarter south-west of Wissembourg.

abundance of marine shells and remains of Saurians. Beneath these, the upper bed of the sandstones that are worked contains fossil wood and *Calamites*. The clay-band that succeeds contains impressions of Ferns and Conifers. It is in the clay-bands covering the lower bed of stone, or the third, that one meets with the most numerous and best preserved impressions of plants. In the clays the most delicate parts of the plants are admirably preserved. One of these lower clay-bands is covered, so to say, with *Posidonomya minuta*; another exhibits the impressions of two crustaceans belonging to the genera *Branchipus* and *Apus*.[1]" (p. 116.)

In 1853 W. P. Schimper mentioned *Posidonomya minuta* in his 'Notes on the Xiphosures of the Trias of Alsace,' forming part of his 'Palæontologica Alsatica,' in the 'Mém. Mus. Nat. Hist. Strasbourg,' 1853, vol. iv. At p. 7 speaking of the *Apudites antiquus*, Schimp. (pl. 3, fig. 2—4), he says, it occurs in numbers in all positions, is wonderfully like the recent *Apus cancriformis*, that annually swarms in some of the pools of the neighbourhood of Strasburg; it is found in argillaceous beds together with *Posidonomya minuta* in the upper part of the Grès bigarré at Soultz-à-bains in the Departement du Bas-Rhin. A *Limulus* (*Limulites Bronnii*) was found in 1851 in the Grès bigarré, near Wasselonne, about ten miles from Strasburg.

Estheria minuta? in the Trias of Northern Italy. In the 'Nuovi Annali Scienz. Nat. Bologna,' 1846, Febbr., Prof. T. A. Catullo mentions the occurrence of *Posidonomya minuta* in the Venetian Alps (See Bronn, quoted above, p. 50). *Posidonomya Wengensis* and *Avicula globulus*, mentioned at page 13 as small bivalves, of doubtful relationship, occurring in the St. Cassian beds of the Tyrol, may be again referred to here.

[1] Schimper and Mougeot, 'Monogr. Plantes Foss. Grès Bigar.,' 1844, p. 5; and 'Mém. Mus. Hist. Nat. Strasbourg,' vol. iv, p. 7.

The following Table shows, in chronological order, the chief recorded occurrences of *Estheria minuta* in the Trias of Germany and France, and the geological horizons in which it has been found:

Date.	Estheria minuta.	Authority quoted.	Author or observer.	Locality.	Geological stage.
1832	Posidonia Keuperiana	Voltz	Dechen	Hall (Würtemberg)	Lettenkohle group.
1832	P. minuta	Alberti	Dechen	Rottweil (Würtemberg)	Lettenkohle group.
1832	P. Goldfussii	Alberti	Dechen	Hall (Würtemberg)	Lettenkohle group.
1832	P. minuta	Goldfuss	Alberti	Sulzbad (Bas-Rhin)	Lower Bunter.
1832	P. Keuperina	Voltz	Alberti	Sulzbad (Bas-Rhin)	Lower Bunter.
1833	P. minuta	Alberti	Zieten	Rottweil (Würtemberg)	Lettenkohle group.
1834	P. minuta	Goldfuss	Alberti	Rottweil (Würtemberg)	Lettenkohle group.
1834	P. minuta	Goldfuss	Alberti	Rottenmünster (Würtemberg)	Lettenkohle group.
1834	P. minuta	Goldfuss	Alberti	Rietheim (Würtemberg)	Lettenkohle group.
1834	P. minuta	Goldfuss	Alberti	Bieberfeld (Würtemberg)	Lettenkohle group.
1834	P. minuta	Goldfuss	Alberti	Sulzbad (Bas-Rhin)	Lower Bunter.
1834	P. minuta	Goldfuss	Alberti	Corcelles (Haute-Saône)	Lettenkohle group.
1834–40	P. minuta	Goldfuss	Goldfuss	Hassfurth (Bavaria)	Lettenkohle group.
1834–40	P. minuta	Goldfuss	Goldfuss	Heilbronn (Würtemberg)	Lettenkohle group.
1834–40	P. minuta	Goldfuss	Goldfuss	Pforzheim (Baden)	Lettenkohle group.
1835–8	Posidonomya minuta	Bronn	Bronn	Täbingen (Würtemberg)	Upper Keuper.
1835–8	Posidonomya minuta	Bronn	Bronn	Sinsheim (Baden) (and other places mentioned in this table)	Lettenkohle group.
1837	Posidonia minuta	Bronn	Voltz	Sulzbad (Bas-Rhin)	Lower Bunter.
1837	Posidonia Albertii	Voltz	Voltz	Sulzbad (Bas-Rhin)	Lower Bunter.
1843	Posidonia minuta	—	Quenstedt	Würtemberg	Lettenkohle group.
1846	P. minuta	—	Catullo	Venetian Alps	?
1846	Posidonomya minuta	—	Volger	Elliehausen (Hanover)	Upper Keuper.
1846	Posidonomya minuta	—	Volger	Abbecke (Hanover)	Upper Bunter.
1849	Posidonomya minuta	—	Herbst	Weimar (Thuringia)	Lettenkohle group.
1851	Posidonomya minuta	Bronn	Bronn	(See above)	—
1852	Posidonia minuta	Alberti	Daubrée	Oberbronn (Bas-Rhin)	Keup. & Lettenkl.
1852	Posidonia minuta	Alberti	Daubrée	Sulzbad (Bas-Rhin)	Lower Bunter.
1853	Posidonomya minuta	—	Schimper	Sulzbad (Bas-Rhin)	Lower Bunter.
1856	Posidonia minuta	Alberti	Bornemann	Johannisthal (Thuringia), &c.	Lettenkohle group.
1857	Posidonomya minuta	—	Seebach	Weimar (Thuringia)	Lettenkohle group.
1860	Posidonia minuta	—	Strombeck	Salzgitter (Hanover)	Lettenkohle group.

We may add Gersfeld (see p. 45) as a locality for *E. minuta* in the Bunter, Haigerloch (Hohenzollern), Nimburg (Breisgau), and Weyhers and Fulda (Bavaria), as other localities for *E. minuta* in the Lettenkohle group, (see p. 44 and p. 45); also Durlach (Baden) and Weyhers (Bavaria) as localities for *E. minuta* in the Muschelkalk, and Halle (Thuringia) for *E. minuta* in the Keuper (page 45).

Table showing the occurrence of Estheria minuta *in the various members of the European Trias.*

Members of the Trias.	England.	Eastern France.	Baden, Würtemberg, and Bavaria.	Hanover.	Thuringia.
Upper Keuper	*	—	Täbingen	Elliehausen, &c.	—
Lower Keuper	—	—	—	—	Weimar.
Lettenkohle	—	*	*	Salzgitter	Johannisthal, &c.
Muschelkalk	—	—	Durlach	—	Weimar.
Upper Bunter	—	—	Gersfeld	Dassel, &c.	—
Lower Bunter	—	*	—	—	—

This Table is constructed on imperfect grounds, and therefore is only offered as a provisional synopsis. I have not seen specimens from the places the names of which are given in the Table, and which have been referred to as localities for the *Estheria* in certain zones. The *asterisks* indicate the zones in the several districts from which I have had specimens under examination.

Habitat of Estheria minuta.—In Alsace, Baden, Würtemberg, Bavaria, Thuringia, and Hanover, the *Estheria minuta* is associated with *Lingula tenuissima,* a marine shell, subjected however to the deteriorating influence of fresh water, if the observations on this point at page 48 bear me out. Other marine molluscs also, such as *Myacites, Gervillia Trigonia* or *Myophoria*, *Pecten*, and *Pleurophorus*, accompany *E. minuta,* at various localities over this wide district, occurring, for the most part, however, in beds amongst which the Estherian shales are occasionally intercalated. The general occurrence of the *Estheriæ* in interlaminated shaly beds, strengthens the opinion that they existed chiefly at the intermediate periods when the fresh water had gained some predominance in the shallow seas or lagoons. In the Bunter Sandstone of Alsace, land-plants occur in the Estherian clays; but here, whilst the freshwater *Apus* is one of the associates of *Estheria*, a *Limulus* intrudes itself in accompanying strata of the same age. (See p. 54).

In some of the beds of the Keuper, crystals of salt have left their casts abundantly, showing both the saltness and the shallowness of the seas or lakes in which the upper Keuper beds were deposited. But however near to these salt-bearing beds the *Estheriæ*

occur, they are never found in them. Such pseudomorphic salt-crystals occur near Lüneberg, in the shales with *Lingula tenuissima*, alternating with the limestones, just above the Lettenkohle group; in the dolomitic beds of which latter *Estheria minuta* occurs (sparingly) with *Myophoriæ*, &c. (See page 51.) So again, in England, the pseudomorphic salt-crystals occur in the Upper Keuper shales immediately overlying the grey sandstones and shales containing *Estheriæ*, but not in the Estherian shales themselves.

Estheria minuta of the English Trias.

In the New Red Sandstone of England *Estheria minuta* is abundant at places, and often occurs as well-grown individuals (larger than any from the Continent that I have yet had an opportunity of seeing), and occasionally (as at Pendock) most perfectly preserved. Judging from the materials at my command, I may say, that the English specimens are more variable in their shape than those found in Germany, since they are apt to contract the posterior portion of the carapace-valves, and so take a subovate form; but I cannot say that such a variation of outline may not be found in the foreign specimens, of which I have not seen a very large series.

The beautifully perfect condition of the carapace in Pl. II, fig. 1, is strongly contrasted, in its neatly definite concentric ridges, and the smooth broad intervals, delicately reticulated by large fine-walled meshes, with the obscurely wrinkled stony casts, indicated by figs. 4 and 5, and with the coarse-walled meshes into which the original reticulation is here modified, the animals having been fossilized in a less accommodating matrix. The German specimens (Pl. I, figs. 28—30) have suffered similar deteriorations.

The measurements of some of the best English specimens are as follow:

From Pendock	Height, rather more than	$\frac{1\frac{1}{2}}{12}$ inch	Proportion, 2 to 3 by 1, or 1 to $1\frac{1}{2}$ by $\frac{1}{2}$.
	Length of valve	$\frac{2\frac{1}{2}}{12}$,,	
	Thickness of closed valves, less than	$\frac{1}{12}$,,	
From Shrewley Common and Pendock	Height	$\frac{1}{6}$ $\frac{2}{12}$,,	Proportion 6 to 9 by 4, or 1 to $1\frac{1}{2}$ by $\frac{3}{4}$.
	Length	$\frac{1}{4}$ $\frac{3}{12}$,,	
	Thickness rather less than	$\frac{1\frac{1}{2}}{12}$,,	
From Somerton	Height, rather less than	$\frac{2}{12}$ inch	Proportion 23 to 30, or 1 : $1\frac{1}{3}$ +
	Length	$\frac{2\frac{1}{2}}{12}$,,	

In my examination of English specimens of *Estheria minuta*, I have had before me specimens from the Upper Trias, or Keuper, of Somersetshire, Worcestershire, Warwickshire, and Leicestershire.

1. A specimen of pinkish-white, fine-grained sandstone, from Shrewley Common, Warwickshire, with convex casts of *Estheriæ*, retaining traces of the shell and its ornament (Pl. II, figs. 5—7), collected by the late Mr. H. E. Strickland, and presented by

him to the Geological Society. This specimen served for an illustration in the 'Geol. Transact.' (2nd ser., vol. v, pl. 28, fig. 4) to the memoir by Strickland and Murchison on the New Red Sandstone. There are numerous *Estheriæ* on a plane of bedding, both large and small; one of the largest is here figured (fig. 5).

Other specimens of sandstone slabs bearing *Estheria minuta*, associated with greenish shale, collected by the Rev. P. B. Brodie, F.G.S., at Shrewley and Rowington, are in the Museum of the Geological Society, in the British Museum, and in the Museum of Practical Geology, Jermyn Street.

2. Compact grey shale, from Pendock, Worcestershire, containing scattered specimens of *Estheria minuta*, often in a most perfect state of preservation. The shell is of a delicate honey colour. These have been collected and liberally communicated by the Rev. W. S. Symonds, F.G.S. The specimen figured (Pl. II, fig. 1) belongs to Professor Tennant, F.G.S.

3. Mr. James Plant, of Leicester, has confided to me some greenish-grey laminated sandstone, with a very few scattered casts of *Estheria minuta*, retaining some of the carapace, from near Leicester. See page 63.

4. Grey fine-grained sandstone, from Somerton, Somersetshire, bearing, in one specimen, numerous convex casts of *Estheria minuta*, both of large size (fig. 4), and small, with traces of the shell remaining; in another specimen crowded and crushed carapaces of *Estheriæ*, and also convex casts with scarcely any shell, all of small size. In both cases the *Estheriæ* lie on the plane of bedding. Mr. Charles Moore, F.G.S., has discovered and lent these interesting specimens.

5. Other English localities for *Estheria minuta* (as I learn by specimens in the Museum of Practical Geology, Jermyn Street) are—

Hill End, between Eastington and Castle Morton, east of the southern part of the Malverns (See 'Mem. Geol. Surv.,' ii, I, p. 120, &c., and map). Coarse greenish-grey sandstone. Collected by Professor Phillips.

Railway-cutting, at High House, near Warwick. Laminated sandstone, in green shale. Mr. Gibbs.

Newent, Gloucestershire. Laminated sandstone, in green shale. Mr. Gibbs.

Needwood Forest. Whitish micaceous sandstone,[1] weathering ferruginous. Mr. Howell.

Moreton-Bagot.[2] Grey sandstone. Mr. J. W. Kirshaw.

Shelsley, Worcestershire. Green shale.

I. *Warwickshire.*—In a memoir, published in 1840 ('Trans. Geolog. Soc.,' 2nd ser., vol. v, part 2), Messrs. Strickland and Murchison described the New Red Sandstone series of Worcestershire, Gloucestershire, and Warwickshire, as consisting of—

[1] The specimens are obscure casts here; and there is some doubt as to whether this sandstone belongs to the Triassic or the Rhætic series.

[2] "North of the fault," Mr. Kirshaw tells me.

Keuper	Red marl	30 to 40 feet thick	At the canal-tunnel in Shrewley Common.
	Fossiliferous sandstone and green marl	20 ,,	
	Red and variegated marl	10 ,,	

Calcareous band,
Bunter Sandstone;[1] occurring at Ambersley, Bromsgrove, and Warwick; also in Cheshire and Shropshire (Grinshill, Hawkestone).

After pointing out the uniform extent of the Keuper Sandstone throughout Worcestershire, Gloucestershire, and Warwickshire, and in which occurs the so-called *Posidonomya minuta*, they remark (p. 337)—

"The exact geological position of this sandstone, which we consider to be the equivalent of the Keuper Sandstone of Suabia and Alsace, is 200 or 300 feet below the lowest beds of the Lias—a position which coincides well with that of the principal mass of this sandstone in Wurtemberg, where one of the authors has examined it. In Germany, however, the Keuper formation contains several courses of sandstone and grit, but always subordinate to thick masses of marl. In England, we have one well-defined band only, which, occurring from 200 to 300 feet below the Lias, is completely and distinctly separated from the Great Red Sandstone of the central counties by a vast thickness of red and green marls, which in certain tracts are saliferous. . . . .

"The Keuper of England (on the whole quite as largely developed as that of Germany) is, like the 'Marnes Irisées' of France, a great marly formation, with one principal band of sandstone[2] subordinate to it, which sandstone is separated by at least 600 feet of marls from the great mass of the underlying New Red Sandstone (Bunter Sandstone)."

In speaking of *Estheria minuta,* which occurs at Shrewley Common, in company with the spine of *Hybodus Keuperianus* (termed *Keuperinus,* at p. 388), "two small teeth of squaloid fish," reptilian foot-tracks, and ripple-mark, they say (p. 338)

"The bivalve shells (pl. 28, fig. 4) appear to be the *Posidonomya minuta* of Bronn ('Lethæa Geognostica,' p. 164, pl. 11, fig. 22), or the *Posidonia minuta* of Goldfuss ('Petrefacten,' pl. 113, fig. 5), and of Zieten ('Versteinerungen Württembergs,' pl. 54, fig. 5)."[3]

And they proceed to observe that—

"In Germany this shell is stated to pervade[4] the New Red system from the 'Keuper' to the 'Bunter Sandstein' inclusive; but in this country it appears peculiar to that band of sandstone which we have proved by stratigraphical evidence to represent the upper formation. It is indeed a very characteristic shell; for, as previously stated, we

[1] The more modern and correct classification of these beds is given further on, at p. 62.

[2] See Mr. Hull's remarks on the Keuper Sandstone of the Midland Counties further on, p. 64.

[3] "Bronn has changed the generic name to *Posidonomya,* the term *Posidonia* being preoccupied in botany. Capt. Portlock has lately detected this shell in the New Red Sandstone of Roan Hill, near Dungannon, Ireland." (See p. 40 of this monograph.)

[4] This is not correct; see the account of the German Trias above, pp. 46 *et seq.*

have detected it at Burge-hill and Inkberrow, in Worcestershire, and at Shrewley Common, in Warwickshire, where it is very abundant in some of the sandstone beds."

One of the specimens of *Estheria minuta* from Shrewley is figured in Pl. II, figs. 5—7; see page 57.

The Rev. P. B. Brodie, F.G.S., in his paper "On the Upper Keuper Sandstone (included in the New Red Marl) of Warwickshire," 'Quart. Journ. Geol.,' 1856, vol. xii, p. 374, &c., observes that—

"The slabs with *Posidonia* occur plentifully along the banks of the canal near Shrewley, in green marls and sandstone, a few feet above the Inferior Red Marl; but the specimens are best preserved in the sandstone;" and he gives the following section seen on the banks of the canal at Shrewley in descending order:

1.	Green marl	3 or 4 inches.
2.	Beds of grey and light-coloured fine-grained sandstone, divided by marl; with *Posidonia minuta* and ripple-marks. In the middle occurs a coarse gritty sandstone, with white specks (less coarse than at Pendock, in Worcestershire), which contains bones, teeth, and spines of *Acrodus* (or *Lophodus*)	1 foot 9 ,,
3.	Green marl	0 ,, $2\frac{1}{2}$,,
4.	More finely grained sandstone, more or less ripple-marked; with footsteps of *Labyrinthodon*	2 feet 3 ,,
5.	Green marl	0 ,, 2 ,,
6.	Hard workable sandstone ("bottom-bed"), the only good building-stone of the locality; with imperfect casts of *Posidonia*	3 ,, 6 ,,
7.	Thin beds of sandstone, divided by green marls; with remains of plants (*Voltzia*, *Calamites* (?), and *Fucoides* (?). This is best seen at Rowington	10 ,, 0 ,,
8.	Red marl.	

In 1857 Mr. Brodie gave a notice ('Quart. Journ. Geol. Soc.,' vol. xiv, p. 165) of the discovery of a fossil fish (*Palæoniscus superstes*, Egerton) in the Upper Keuper Sandstone at Rowington, Warwickshire, about twelve miles from Shrewley Common; and as there is some interest belonging to the association of fish-remains with *Estheria* in the section at Rowington, which is comparable with that above given, and as Mr. Brodie has favoured me with a note on the occurrence of *Estheriæ* in these beds, I here subjoin a description of the Rowington Section.

"About half way down the hill on which the church (Rowington) stands are certain kinds of brashy stone, more or less sandy and marly, and having a very irregular fracture; in these I discovered the new fish which Sir Philip Egerton has described above under the name of *Palæoniscus superstes*. The vicinity of the vicarage affords the following section in descending order:

	Feet.	Inches.
Thin beds of sandy stone,[1] in green marl; brashy bed	2	0
Sandstone / Green marl / Sandstone	0	11
Green marly stone, with so-called "Fucoid" impressions	0	6
Several beds of ripple-marked sandstone, thickness not exposed.		

"At a somewhat lower level on the canal-bank, at the west end, the section is continued as follows:

	Feet.	Inches.
Beds of rubbly sandstone and marl, much broken; with remains of Plants	5	0
Grey sandstone, divided by green marls, full of Fucoids?	10 to 12	0
Hard sandstone[2]	4	0
Green shaly marl (a few inches).		
Red marl."		

Mr. Brodie has also kindly communicated to me by letter (January 1861) the following information.

"As to the *Palæoniscus*, I found it in some green marly shales, higher than the shales containing *Estheriæ* most abundantly, which usually occur near the base of the Keuper, just above the red marls. I have not seen *Estheriæ* in these marls, although they may occur.

"*Estheria* occurs abundantly in the thick sandstones at the bottom, as well as in the green marls which underlie it, but more sparingly in the beds above, and in some bands it is not met with at all. The chief repositories of these Crustaceans is in the thick sandstone and the green marls, and sandstone above both. They are best preserved in the marls."

II. *Worcestershire.*—In 1855, the Rev. W. S. Symonds, F.G.S., mentioned the occurrence of "*Posidonomya minuta*" in the Keuper Sandstone of Pendock, Worcestershire. The following are the particulars of the section, as published in Mr. Symonds' paper in the 'Quart. Journ. Geol. Soc.,' vol. ix, p. 450:

The Keuper Sandstone quarry, from which the fossils here referred to were obtained, is situated in the village of Pendock, about three miles from the base of the south end of the Malverns, and exactly opposite the Holly Bush Pass. These sandstones are quarried to the depth of fourteen or fifteen feet. They dip under the Upper Red Marls and Lower Lias of the Berrow Hill, at an angle of from 5° to 6°. Their position as regards the Bone-bed, at the base of the Lias, cannot be less than from 250 to 300 feet below that deposit.

[1] The *Palæoniscus superstes* occurred in this bed.

[2] Another specimen of *Palæoniscus* has been found in the lowest bed of the Keuper Sandstone here.

The section in the quarry exhibits the following series :

	Feet.	Inches.	
Surface-soil	2	6	
Marl	2	6	*Estheriæ.*
Sandstone		7	Fish-teeth.
Marl		5	*Estheriæ.*
Sandstone		6	
Marl		1	
Sandstone		5	
Osseous conglomerate, or Bone-bed		1½	Fish-teeth and bones (*Lophodus, &c.*).
Marl and thin sandstone	1	6	*Estheriæ.*
Thick sandstone and marl. Thickness unknown			Plants (*Equisetites* or *Calamites*). (Plant-remains occur also in the other beds.)

A specimen from this quarry is figured in Plate II, figs. 1—3 ; see page 57.

Mr. Symonds has also informed me by letter, dated February 2nd, 1861, that the same little fossil shells were found at the eastern entrance of the Malvern tunnel,[1] on the Worcester and Hereford Railway, in grey shales associated with sandstones, and belonging to the same series of beds as those of the Pendock section, namely, the Upper Keuper Shales and Sandstones.[2] *Estheria* is here associated with teeth and spines of *Lophodus*. The Keuper beds of this district east of the Malvern range were described in 1848, in the 'Memoirs Geol. Survey,' vol. ii, part 1, pp. 119, &c., by Prof. Phillips, who found *E. minuta* at Hill End (see page 58).

The following approximative section of the New Red Sandstone of Worcestershire has been drawn up with the kind help of Mr. George E. Roberts, author of 'The Rocks of Worcestershire,' &c., &c. :

			Feet.
Upper Keuper.	1. Upper Keuper (grey and red) Marls, with pseudomorphic salt-crystals. (Well seen at Crowle, 4 miles east of Worcester)		40
	2. Upper Keuper Sandstone with *Estheria*, Plant-remains, and Fish-remains. (Well seen at Pendock)		20
	3. Lower Keuper (red) Marls	Upper variegated marls. Pseudomorphs of salt and gypsum in the upper portions. (Worcester Railway-station)	1000
		Lower red marls ; saliferous. (Droitwich)	

[1] See the section published in the 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 154.

[2] The order of the Triassic beds in this district are—

1. Upper Keuper (grey and red) Marls (with pseudomorphic salt-crystals).
2. Upper Keuper Sandstones (with *Estheriæ* and Fish-remains).
3. Lower Keuper (red) Marls.
4. Lower Keuper Sandstone (equivalent to the "water-stones"). See 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 152.
5. Upper Red Sandstone (Bromesberrow beds).
6. Lower Red Sandstone (Stourport beds).

		Feet.	Feet.
Lower Keuper.	4. Lower Keuper Sandstone (including the water-stones):		
	1. Reddish sandstone, micaceous; with Plant-remains (Ombersley, Bellbroughton)	20	
	2. Cupriferous sandstone, micaceous (Ombersley, Hadley, Bellbroughton)	200	
	3. Thin-bedded sandstone, red and white, micaceous (Drayton, Bellbroughton)	30	
	4. Thin, greyish, calcareous bands, magnesian (?) (Drayton)	6	
	5. Breccia, somewhat calcareous, reddish; 6. Conglomerate, red (Hartlebury)	60	316
Bunter—			
	5. Upper soft red sandstone (Bromesberrow)		200
	6. Reddish conglomerate, variable in constitution (Kidderminster and Wolverley)		400
	7. Lower soft red sandstone (Habberley and Stourport)		200

III. *Leicestershire.*—In a paper on "The Upper Keuper Sandstone (included in the New Red Marls) and its Fossils at Leicester," 1856, 'Quart. Journ. Geol. Soc.,' vol. xii, p. 369, &c., Mr. James Plant gives the following section of the strata (p. 372), and note on the fossils. Amongst the latter is *Estheria minuta.*

Upper Keuper.	*a.* Upper Keuper Marls, containing beds of gypsum and several thin bands of green marly sandstone, on which are found numerous pseudomorphic salt-crystals; thickness from 80 to 120 feet.
	b. Thin sandy shales, with way-boards of green marl; 25 to 30 feet.
	c. Thick beds of soft white sandstone; 20 to 30 feet.
	d. Thin sandy shales, similar to *b*; 35 feet (in laminæ, varying from half an inch to four inches in thickness). *Estheriæ.*
	Red clay.

Fossils found in these Upper Keuper beds:

Plants.—Casts of *Echinostachys oblongus* and *Equiseta*; remains of *Voltzia* and *Algæ* (?).

Annelids.—Cololites and casts of tubes.

Estheria minuta, found in the green marls and thin sandy shales of beds *d* (rare). Found at Dane Hill, and Belgrave, Leicester.

Fishes.—Teeth of Placoid fishes; Ichthyodorulites; fragments of Bones; Coprolites (?); in beds *c* and *d.*

Sand-casts of salt-crystals, and traces of Corallines (?) in beds *a.*

Mr. Plant has kindly submitted some specimens of the laminated sandstone, with *Estheria minuta,* for my inspection (see above, p. 58); he has also informed me lately that he has met with larger numbers in a group, at a cutting two miles from Leicester, in the same beds.

IV. *Somersetshire.*—Mr. Charles Moore, F.G.S., of Bath, has met with specimens of the Triassic *Estheria,* near the following places in Somersetshire—North Curry, Taunton,

and Somerton (Pl. II, fig. 4, page 58). The section at the first-named place is described by him in the 'Quart. Journ. Geol. Soc.,' vol xvi, p. 486, as being (immediately under the Rhætic beds)—

	Feet.	Inches.
Light-blue marl	6	0
Variegated blue and red marls, with alabaster ....about	100	0
Various beds of dull grey and brown sandstone, enclosing nodules of marl, and containing *Estheriæ*, Plants, traces of Fish-scales, and a Reptilian bone	3	6
Blue and red marls	21	3
Red and blue compact marls ....about	40	0

These are followed by other marls and sandstone, seen at Knap, about a mile and a half distant.

At page 490, in the same memoir, Mr. C. Moore states that near Stoke-St.-Mary, "in the sides of the turnpike-road leading to Taunton, thin beds of Keuper are present with *Posidonomya minuta*."

The beds of Keuper at Somerton, Mr. Moore informs me, are of the same age as those that he has noticed at Curry, but very much thicker.

V. *The New Red Sandstone in Cheshire and Warwickshire.*—The position of the *Estheriæ* in the Trias is shown by the following table of the Triassic strata in Cheshire, for which I am indebted to my friend, Mr. E. Hull, F.G.S., one of the Geological Surveyors, who has especially studied the Triassic formation of England. The additional notes, also, which Mr. Hull has kindly communicated to me, furnish us with further information relative to the correlation of the Trias of Warwickshire with that of Cheshire.

The Triassic Group in Cheshire.

KEUPER DIVISION. Thickness, more than 3000 feet.	1. Red and variegated marls, with bands of grey and white sandstone ("Upper Keuper Sandstone"). Fossils: *Estheria*[1] and *Annelides*. (*Palæoniscus superstes*, Egerton, at Rowington, Warwickshire. *Estheriæ* and remains of Fishes and Plants in Worcestershire, Warwickshire, Leicestershire, &c.) Beds of rock-salt[2] and gypsum occur in these marls, probably towards the base. Thickness, nearly 3000 feet. 2. Flaggy, micaceous, rippled sandstones and marls ("Waterstones" of William Smith, Binney, and Ormerod), passing downwards into white and reddish freestones, and resting on a base of calcareous breccia. "Lower Keuper Sandstone;" thickness, 450 feet. Fossils: *Cheirotherium; Annelides*. (*Rhynchosaurus*, at Grinsill, Salop; *Dipteronotus cyphus*, Egerton, at Bromsgrove; *Cheirotherium*, Derbyshire and Staffordshire).

[1] Mr. Hull informs me that the *Estheria* occurs in the bands of sandstone in the red and variegated marls; and that it is not common in Cheshire, but is more plentiful in the Midland Counties in this position.

[2] Pseudomorphs of salt occur (according to Mr. Hull) plentifully in the sandstone and the sandy

BUNTER DIVISION. Thickness, 1900 or 2000 feet.	1. Upper mottled sandstone. Soft, fine-grained, variegated sandstone, without pebbles: 700 feet. No fossils. 2. Conglomerate-beds. Red pebbly sandstone, with veins of protoxide of iron and oxide of manganese: 700 feet. Obscure impressions of drifted Plants. 3. Lower mottled sandstone. Soft variegated sandstone: 500 feet. No fossils.

In consequence of the south-easterly thinning out of the Triassic group,[1] all the divisions of the above table, as they occur in Cheshire, become reduced in thickness; and some are entirely absent in Warwickshire, as will be seen by the following synoptical comparison, kindly supplied by Mr. E. Hull.

	Cheshire.		West Warwickshire.	East Warwickshire.
		Feet.	Feet.	Feet.
KEUPER.	Red marl, including the Upper Keuper sandstone[2]	above 3000	 600	 450
	Lower Keuper sandstone	„ 450	 200	 150
BUNTER.	Upper mottled sandstone	„ 700	 400	.... (Absent.)
	Conglomerate-beds..............	„ 700	 400	
	Lower mottled sandstone	„ 500	 100	
		5350 (nearly)	1700 (nearly)	600 (nearly).

Habitat of Estheria minuta.—In England there are no marine organisms (fishes being excluded as doubtful witnesses) accompanying the *Estheriæ* of the Keuper; and the latter might have been at once regarded as of equally freshwater habits with their recent congeners, were it not that the salt condition of the waters depositing much of the Keuper sandstones and shales is proved by the masses of rock-salt and by the casts of the cubical crystals of salt occurring abundantly in the same beds all over the country of the

beds of the red marl in Cheshire and the Midland counties. It is desirable that we should know whether the salt-crystals and the *Estheriæ* occur in the same or in different layers in this district. Salt-pseudomorphs are described by Messrs. Strickland, Ormerod, and Smyth, in the 'Quart. Journ. Geol. Soc.,' vol. ix, pp. 5 and 187.

For special information respecting the salt-beds at Northwich, &c., see papers by Messrs. Binney and Ormerod, 'Quart. Journ. Geol. Soc.,' vol. ii and vol. iv. For remarks on the unconformability of the Keuper to the Bunter, see Mr. Hull's paper in the 'Quart. Journ. Geol. Soc.,' vol. xvi, p. 76; and for this and other points belonging to the character and distribution of the Triassic beds see the 'Memoirs Geol Survey' (Explanations of the Maps and Sections).

[1] See 'Quart. Journ. Geol.,' vol. xvi, p. 63, &c.

[2] "With regard to the term 'Upper Keuper Sandstone,'" says Mr. E. Hull, "I think that it can only be retained as applicable to the midland counties. In the northern counties this rock is not confined to one definite zone in the red marl, but is distributed in thin layers throughout nearly the whole subdivision. While, therefore, in Worcestershire, Warwickshire, and Leicestershire (as shown by Strickland, Murchison, Brodie, &c.), we may divide the red marl into three portions, the central of which is the 'Upper Keuper Sandstone,' in Notts, Cheshire, and Salop, no such divisions are possible, as the whole is essentially one group."

Keuper. Still *Estheriæ* have not been found (to my knowledge) in these salt-bearing beds. They appear to keep a definite line above the horizon of the rock-salt and beneath that of the salt-pseudomorphs, and may represent a nearly, if not quite, freshwater condition of the waters of the Upper Triassic period for the localities in which they occur.

In Gloucestershire (near Tewkesbury), and near Pendock, and at the eastern end of the Malvern Tunnel, in Worcestershire (Prof. Morris), the salt-crystals[1] abound in the thin sandstone imbedded in greenish-grey shale above the sandstone and shale with *Estheriæ* and plants.

In Leicestershire Mr. James Plant has found the Keuper to be rich in these pseudomorphs at some places; he informs me that he has taken these salt-casts most abundantly at four localities, twenty miles apart, namely, Chilwell, Orton, Beaumanor Park, and Spinney Hills, near Leicester. In all these cases he considers the beds to be either the Upper Keuper Marls or the sandy shales immediately beneath, except at Orton,[2] where, perhaps, there are the still lower sandy shales (containing *Estheriæ*, near Leicester), lying on red marl.

Estheria minuta, Var. Brodieana. Pl. II, figs. 8—15.

Cyclas-like Bivalve, *Brodie.* Proceed. Geol. Soc., 1842, vol. v, pp. 14 and 15; Hist. Fossil Insects, Second. Rocks, England, 1845, pp. 58, 79, &c.

Cyclas, sp., *Duff.* Geology of Moray, p. 1842, p. 19.

Estheria minuta, *Wright.* Quart. Journ. Geol. Soc., 1860, vol. xvi, pp. 378, 387, 395.

Estheria, *C. Moore.* Quart. Journ. Geol. Soc., 1860, vol. xvi, p. 446; and 1861, vol. xvii, p. 497, 512.

From Westbury	Height	$\frac{1}{12}$ inch	Proportion, 1 : $1\frac{1}{2}$.
	Length	$\frac{1\frac{1}{2}}{12}$,,	
,,	Height, rather more than	$\frac{1}{12}$,,	,, 9 to 16, or 1 : $1\frac{3}{4}$+
	Length	$\frac{2}{12}$,,	
From Wainlode	Height of valve	$\frac{1}{12}$,,	,, 12 to 17, by 5; or 1 : $1\frac{1}{2}$—, by $\frac{1}{2}$—
	Length, less than	$\frac{1\frac{1}{2}}{12}$,,	
	Thickness, less than	$\frac{\frac{1}{2}}{12}$,,	
,,	Height, less than	$\frac{1}{12}$,,	,, 5 to 7, or 1 : $1\frac{1}{2}$—
	Length, more than	$\frac{1}{12}$,,	
From Linksfield	Height	$\frac{1\frac{1}{3}}{12}$,,	,, 8 to 11, or 1 : $1\frac{1}{2}$—
	Length, less than	$\frac{2}{12}$,,	

[1] For notices by Mr. Strickland and Mr. Ormerod of the pseudomorphic salt-crystals, or rather sandstone casts of the hollows left by salt-crystals, see 'Quart. Journ. Geol. Soc.,' vol. ix, pp. 5, 187.

[2] At Orton, Mr. Plant informs me, the sandstone is only four feet thick, but is so widely spread and so horizontal that it is used in its natural position as threshing-floors in barns, and on these can be discerned the pseudomorphs and ripple-marks. Such sandstone is similarly used in Worcestershire.

This differs from *Estheria minuta* of the Trias in being smaller (frequently not much more than half the size), and in having a relatively smaller reticulation of the surface[1] (6—8 meshes between the ridges). It seems to have similar variations of shape as the type exhibits.

This variety I have named *Brodieana,* after the Rev. P. B. Brodie, F.G.S., who first noticed it in the strata formerly known as the Lower Lias Shales, and now classified as the Rhætic beds, or the passage-beds between the Trias and Lias. I have it from Somersetshire, Gloucestershire, Warwickshire, and Worcestershire (England), and from Morayshire (Scotland).

I. *Gloucestershire and Warwickshire.*—In Gloucestershire this *Estheria* occurs at Westbury Cliff, near Newnham, and at Wainlode Cliff, near Tewkesbury, both on the Severn. From the former place I have seen specimens in a light, yellowish-grey, soft, fine-grained limestone (with numerous small fragments of plants in some specimens, without them in others). It is sometimes scattered, sometimes numerous, on the planes of bedding, and is usually flattened, but sometimes retains its convexity; occasionally a specimen is seen imbedded in an upright position, showing the dorsal aspect of the carapace, more or less crushed. The specimens were collected by the Rev. P. B. Brodie and by W. R. Binfield, Esq., and are in the museum of the Geological Society. The Estherian limestone is described as occurring in nodules at a certain horizon in the section. (See pp. 69, 70.)

The specimens from Wainlode Cliff consist of a bluish-grey limestone (weathering brownish-grey), full of dark-brown *Estheriæ* (Pl. II, figs. 12—15), retaining their shell and their convex form, and lying in the matrix in every position. Some of these specimens are in the museums of the Geological Society and the Geological Survey, and others were given me by the Rev. Mr. Brodie, in February, 1861; none of them contain plant-remains, *Cypridæ, Unio,* nor fish-scales, such as are noted as belonging to bed No. 6 of Mr. Brodie's section, quoted at page 68; probably the *Estheriæ* occur only in the nodules (as at Westbury), and the other fossils in the accompanying clay or limestone.[2]

In November, 1842, the Rev. P. B. Brodie, F.G.S., ('Proceed. Geol. Soc.,' vol. iv, p. 14, &c.), described the strata at Wainlode Cliff, on the south bank of the Severn, near Tewkesbury, and at Westbury, near Newnham, on the Severn, eight miles below Gloucester, especially with reference to the occurrence of fossil insects in some of these beds that lie between the Red Marls of the Trias and the Lower Lias Shales. In noticing the characters and position of these strata, Mr. Brodie observed the occurrence of numerous small bivalve shells, much resembling *Cyclas,* in some of the layers; and specimens were given

[1] Much resembling that of the recent, and somewhat similar, but larger, *E. polita,* Baird, 'Proc. Zool. Soc.,' 1849, p. 88, Annul., pl. 11, fig. 3.

[2] Still more exact observations as to the distribution of *Entomostraca,* Insects, Plants, &c., in these Rhætic beds of Westbury, Wainlode, &c., are highly desirable.

by him to the museum of the Geological Society. These Cyclas-looking shells are *Estheriæ*.

In his 'History of the Fossil Insects in the Secondary Rocks of England,' 1845, Mr. Brodie gave fuller details of these sections. That of Wainlode (p. 58) is as follows[1]:

		Feet.	Inches.
1.	Black clay	3	0
2.	Hard blue limestone, with *Ostrea*, *Modiola minima*, and other shells	0	4
3.	Yellow shale, with traces of Fucoids	0	10
4.	Grey and blue limestone, with Insect-remains	0	5
5.	Marly clay	5	3
6.	Hard, yellow, nodular limestone, with small shells like *Cyclas* (*Estheriæ*), *Cypris*, *Unio*, Plant-remains (*Naiades*), and some scales of Fishes, varying from 6 in. to 8		
7.	Yellow clay	9	0
8.	Black shale	3	0
9.	Hard, grey stone, with impressions of Fucoids on the upper surface, and with scales and teeth of Fishes (*Gyrolepis, Hybodus, Acrodus, Saurichthys, &c.*)	0	1
10.	Black slaty clay	1	6
11.	Pecten-bed. Very hard, brownish, pyritous stone, with Pectens (*Pecten Valoniensis*), and one or two other shells (*Avicula contorta*)	0	4
12.	Black shale	8	0
13.	Bone-bed. Hard, thin, pyritous bed of bones, scales, and teeth of Fishes,[2] associated with a white and yellow sandstone full of casts of *Pullastra arenicola*	0	3
14.	Black shale	2	0
	Green and red marls of the New Red Sandstone.		
		34	8

Specimens of *Estheria minuta*, var. *Brodieana*, from Wainlode Cliff are figured, Pl. II, figs. 12—15; they vie with the specimens of *E. minuta* from Pendock in their good state of preservation.

At page 79 of 'Hist. Fos. Insects,' Mr. Brodie describes the section at Garden Cliff, Westbury, with its "hard, yellow, and grey limestone, often slaty and sandy, with supposed Cyclas," &c.; but we here copy the more detailed section given by Dr. T. Wright, F.G.S., in the 'Quart. Journ. Geol. Soc.,' 1860, vol. xvi, p. 378.

[1] See also 'Quart. Journ. Geol. Soc.,' xvi, p. 379.

[2] The following are the genera of Fishes that occur in the Bone-bed of England and the Continent (see Dr. Wright's paper, 'Quart. Journ. Geol. Soc.,' vol. xvi, p. 388):—*Gyrolepis, Hybodus, Acrodus, Nemacanthus, Ceratodus*, and *Saurichthys*.

"Section of the *Avicula-contorta*-beds at Garden Cliff, near Westbury-on-Severn. (The beds are described in descending order.)

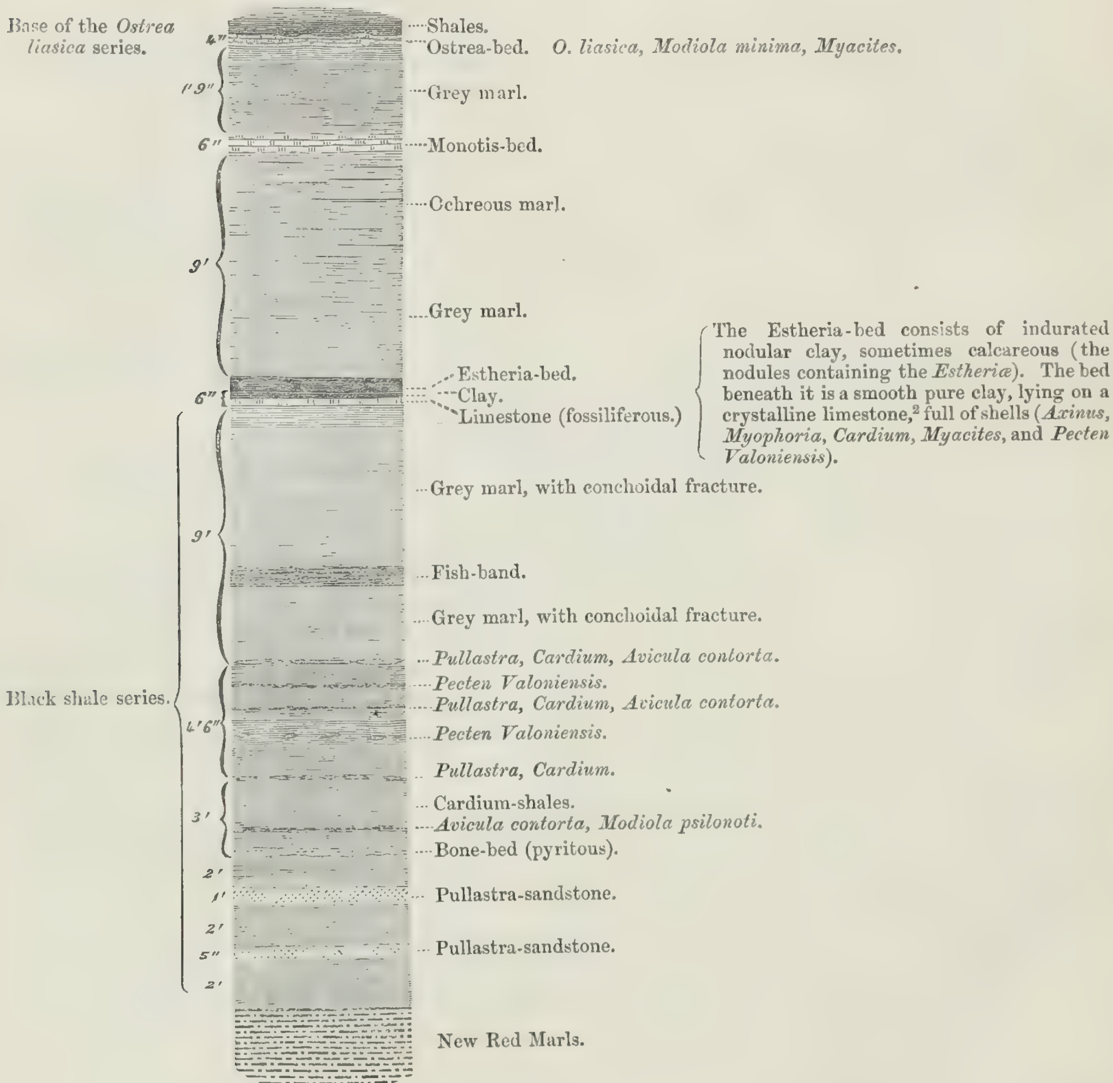
No.	Lithology.	ft.	in.	Organic Remains.
1.	The *Ostrea-bed;* a hard, dark-grey, argillaceous Lias limestone; many shells on the surface	0	4	*Ostrea liasica*, Strickl., *Modiola minima*, Sow., *Cardium*, n. sp. (This bed is one of the lowest of the Ammonites-planorbis-series.)
2.	Greyish clay ...from 1 ft. to	2	0	
3.	The *Monotis-bed;* a cream-coloured, argillaceous fissile limestone (the "Insect-limestone" of Brodie) from 4 in. to	0	8	The Monotis-bed contains *Monotis decussata*, Goldf., in great profusion in the upper laminæ; and in the lower, *Myacites musculoides*, Schl. (?), *Cardium Rhæticum*, Mer., *Modiola minima*, Sow., *Monotis decussata*, and *Ostrea liassica*.
4.	Greyish shaly clay ...from 1 ft. to	2	0	
5.	The *Estheria-bed;* a light-grey nodular limestone, in parts shelly; forming a prominent band in the cliff	1	0	The Estheria-bed contains in some part nests of *Estheria minuta*, Bronn. In the shelly portions I have found *Pecten Valoniensis*, Defr. (Brodie mentions also the occurrence of *Cypridæ*, Plants (*Naiades*), and scales of Fishes in this bed.)
6.	Dark friable shale; containing many fossiliferous seams ...8 ft. to	10	0	Many small compressed *Conchifera*, which have not been determined.
7.	Dark shaly clay; containing many compressed shells	1	0	*Pullastra.*
8.	Dark shale; containing many seams of compressed shells	4	0	
9.	The *Pecten-bed;* a dark argillaceous limestone	0	2	*Pecten Valoniensis*, Defr., numerous and compressed.
10.	Black shales	6	0	Fossils rare; bodies resembling Coprolites.
11.	The *Bone-bed;* a thin band of greyish calcareo-siliceous rock; containing osseous *débris* and much pyrites. A true bone-breccia	0	1	Bones of Saurians and Fishes, teeth of Reptiles, teeth of Fishes, as *Saurichthys, Acrodus, Hybodus*, and *Ceratodus*, with many Coprolites.
12.	Black shales	2	0	
13.	Dark-grey micaceous sandstone; ripple-marked on the upper surface; forming a prominent bed in the cliff; large slabs lie on the shore ...9 in. to	1	0	*Avicula contorta*, Portl., *Cardium Rhæticum*, and *Pullastra arenicola*, Strickl.
14.	Black shale	2	0	
15.	A band of grit resembling No. 13; containing scales and teeth and much pyrites	0	4	Bones, scales, and teeth of Fishes; *Pullastra arenicola.*
16.	Hard black shale	2	0	Bodies resembling Coprolites.
	Grey marls of the Keuper.			

"The beds are all conformable, and dip to the S.E. at angles varying from 2° to 4°. The Keuper Marls are exposed to the Cliff, with a thickness of above eighty feet. When

this section is lit up by the sun's rays, and seen at a distance of two miles, it has a most beautifully picturesque appearance from the varied colouring of its different beds."

The strata of this section, from No. 2 to No. 16, inclusive, belong to the "Avicula-contorta-series" of Oppel, Wright, and other palæontologists, or to the "Rhætic formation" of Gümbel, C. Moore, and others, and are separated from the Lias above and the Trias below more or less distinctly according to the palæontological views of the several observers.[1]

To R. Etheridge, Esq., F.G.S., of the Geological Survey, I am indebted for the accompanying, still more accurately measured, section and diagram of the interesting strata of Garden Cliff, Westbury.



[1] See Mr. C. Moore's memoir on this formation in the 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 483.

[2] The same as the fossiliferous bed at Beer-Crowcombe, in Somersetshire, described by Mr. C. Moore, 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 486.

In his work on 'Fossil Insects,' at page 82, Mr. Brodie also notices the existence of a band of white stone with "Cyclas?" in the cliff at Aust Passage, on the Severn, about twelve miles from Bristol, and this he refers to the Estherian zone of Westbury and Wainlode, or what he terms the "Cypris-bed." And at page 72 Mr. Brodie mentions that Mr. H. E. Strickland found "the yellow Cypris-limestone with Cyclas," at Dunhamstead, on the line of the Gloucester and Birmingham Railway, near the Droitwich station.[1]

Other sections of the Rhætic beds in Warwickshire and elsewhere are described by Dr. T. Wright in his paper 'On the Lower Lias and Bone-bed,' already referred to. Thus, at pages 386 and 387 we find the following section of Messrs. Greaves and Kirshaw's quarry at Wilmcote, near Stratford-on-Avon:

Beds Nos. 1—20.—Clays, shales, and limestones, belonging to the zone characterised by *Ammonites planorbis*.

	No.		ft.	in.	
Ostrea and Saurian Beds.	21.	Dark, hard, stony clay	0	7	"Ruskins." *Plesiosaurus megacephalus*, Stutchb. (Warwick Museum).
	22.	Dark-blue limestone and clay	0	9	"Blue Blocks" or "Fire-stone blocks."
	23.	Dark clay, laminated	1	0	
	24.	Dark greyish limestone	0	4½	"Pendle and Jackets." *Ostrea liasica*, *Modiola minima*, and *Cardium*.
	25.	Hard crystalline limestone			Fire-stone, top bed.
	26.	Hard crystalline limestone	1	2	Fire-stone, middle bed.
	27.	Hard crystalline limestone			Fire-stone, bottom-bed.
					Bottom of the quarry; shaft sunk below this.
	28.	Hard, dark, slaty shale	1	0	
	29.	Hard shelly limestone	0	1	"The Guinea-bed." *Avicula*, *Lima*, *Ostrea*, &c.
	30.	Green clunchy shale	3	0	
Westbury Beds.	31.	Fine-grained greenish marl	0	3	Estheria-bed. *Estheria minuta* in clusters.[2]
	32.	Blackish shales, not laminated	12	6	
	33.	Close, laminated, micaceous, greenish-black shale	1	0	
	34.	Closely laminated shale	0	6	
	35.	Laminated shale	1	6	Upper Pullastra-bed. *Avicula contorta*, *Pullastra arenicola*, and *Cardium*.
	36.	Hard, close shale, not laminated	2	6	
	37.	Dark clay and shale	0	6	
	38.	Strong laminated clay, with septaria	1	3	
	39.	Clay, with shells	1	8	Pecten-bed. *Pecten Valoniensis*.
	40.	Black, hard, laminated clay	4	0	
	41.	Pyritic stone, with shells	0	1	Lower Pullastra-bed.
	42.	Black clunchy clay	0	8	
	43.	Light, soft, brown clay	0	0	

[1] See also 'Proceed. Geol. Soc.,' vol. iii, pp. 315, 587, 732.

[2] Mr. Kirshaw has favoured me with a specimen from this Estheria-bed. It is part of a nodule of grey compact limestone, traversed by a band of *Estheriæ*, both well preserved and in fragments.

At pages 394 and 395 of the same memoir there is the following section taken at Binton, in Warwickshire:

Section of the Zones of *Ammonites planorbis* and *Avicula contorta*, at Binton, Warwickshire.

Beds Nos. 1—36 are thin limestones and clays, 24 feet; with *Ichthyosaurus*, Fishes, *Ammonites planorbis*, *Lima*, *Cardium*, *Ostrea liasica*, *Modiola minima*, *Myacites*, *Avicula*, *Monotis*, *Cidaris*, *Hemipedina*, Insects, and a Fern.

No.		Thickness. ft.	in.	
37.	Thick clay-bed; yellowish-blue; breaking in angular fragments	8	0	[Belonging to the zone of *Avicula contorta*.]
38.	Dark ferruginous clay, with conchoidal fracture	0	4	Estheria-bed. *Estheria minuta.*
39.	Clay			"Clear blue blocks."
40.	Laminated clays	3	0	
41.	Light-coloured sandstone; micaceous	0	1	*Pullastra arenicola*, Strickl.
42.	Brown clay	0	2	
43.	Sandstone; micaceous	0	2	*Pullastra arenicola*, Strickl.
44.	Dark shaly clay	0	6	
45.	Soft sandstone	0	1	
46.	Black clay	0	3	
47.	Ferruginous vein, sand	?		
48.	Grey Keuper marls			

Mr. J. W. Kirshaw, F.G.S., of Warwick, has favoured me with several specimens of *Estheria minuta*, var. *Brodieana* (January 9th, 1862), and with the following note on its occurrence in the district to which he has given much attention.

"The Estheria-bed of the Rhætic formation is very persistent below either the 'White Lias' or the 'Firestone beds,' wherever these occur. There is generally a greenish-grey clunchy marl above and below the bed. I have found this stratum in Warwickshire,—in the railway-cutting north of Stratford; at Ashton-Cantlow; at Wilmcote (see above, page 71); between Wootton Park and Shelfield, S.W. of Henley-in-Arden (whitish, earthy limestone, with well-preserved *Estheriæ*); at Brown's Wood, Moreton-Baggott (compact greyish marlstone, with *Estheriæ* well preserved[1]); at the bottom of the Harbury cutting on the Oxford, Worcester, and Wolverhampton Railway, near Leamington (yellowish-grey, calcareous, laminated sandstone); at the bottom of Ufton Hill; at Long-Itchington; in Worcestershire, at Cracombe, N.W. of Evesham (grey earthy limestone, like

[1] This Estherian rock is much like that found by boring at Wilmcote, but it is browner and less calcareous.

the Estherian bed at Westbury, and a yellowish-grey limestone), and at Hob-Lench.[1]

"Mr. Tomes and I found it also at Barrow, in Leicestershire, and at Penarth, South Wales; and when we were with Mr. Charles Moore at Vallis, near Frome, we found *Estheriæ* in the same relative position." (See below.)

II. *Staffordshire.*—In Staffordshire also this *Estheria* appears to have been met with, according to the following quotation from Dr. T. Wright's paper. (*Loc. cit.*, p. 385)—

"The Sandstone of the Bone-bed has been found, by Mr. H. Howell, of the Geological Survey, at Abbot's Park, near Abbot's-Bromley, Staffordshire, at the base of an outlier of the Lower Lias. In a section which is exposed in the road at Buttermilk Hill, on the northern escarpment of this outlier, Mr. Howell found some beds of impure limestone, above which is a thin bed of micaceous sandstone containing *Pullastra arenicola*, Strickland, and what appear to be *Estheriæ*, all of which are in moulds and casts."

III. *Somersetshire.*—The same variety of *Estheria minuta* has been found by Mr. Charles Moore, F.G.S., of Bath, in some Rhætic beds which he discovered a few years since in the neighbourhood of Frome, Somersetshire. He thus describes the section of the strata referred to ('Quart. Journ. Geol. Soc.,' vol. xvii, p. 497):

"In the Vallis, near Frome, there are quarries worked for the Carboniferous Limestone, some of the beds of which have their upturned edges capped with horizontal Inferior Oolite. In a section near Hapsford Mills I noticed a conglomerate with a few thin intermediate layers of stone and clay. The limestone in this section has a dip of 35° N.W., and is worked to a depth of fifteen feet. Lying upon it there is a band of blue clay, four inches in thickness, which, on close examination, I found to contain a very interesting fauna. Associated with remains of Fishes and Reptiles of the Bone-bed age, it yielded *Avicula contorta, Ostrea interstriata* abundantly, *Pecten Valoniensis*, with other genera never before noticed in beds of this age, such as *Chiton, Pollicipes*, &c. This clay is succeeded by a dense conglomerate of rounded siliceous pebbles, two feet thick, and containing, though rarely, Fish-teeth and scales; another blue clay of four inches succeeds, but without organic remains; then a grey conglomerate, four inches, upon which there are courses of grey or cream-coloured nodular limestone, intermingled with a grey clay, one foot in thickness. In this, organic remains are extremely rare. Specimens of *Estheria*, Insects, and one block containing Plant-remains are all I have obtained. Above the latter are beds of Inferior Oolite, twelve feet in thickness, conglomeratic at their base.

"The interposed beds of conglomerate, stone, and clay between the Inferior Oolite and the Carboniferous Limestone, although but four feet in thickness, may represent in this section the geological eras of the *White Lias*, the *Estheria-beds* of Warwickshire and

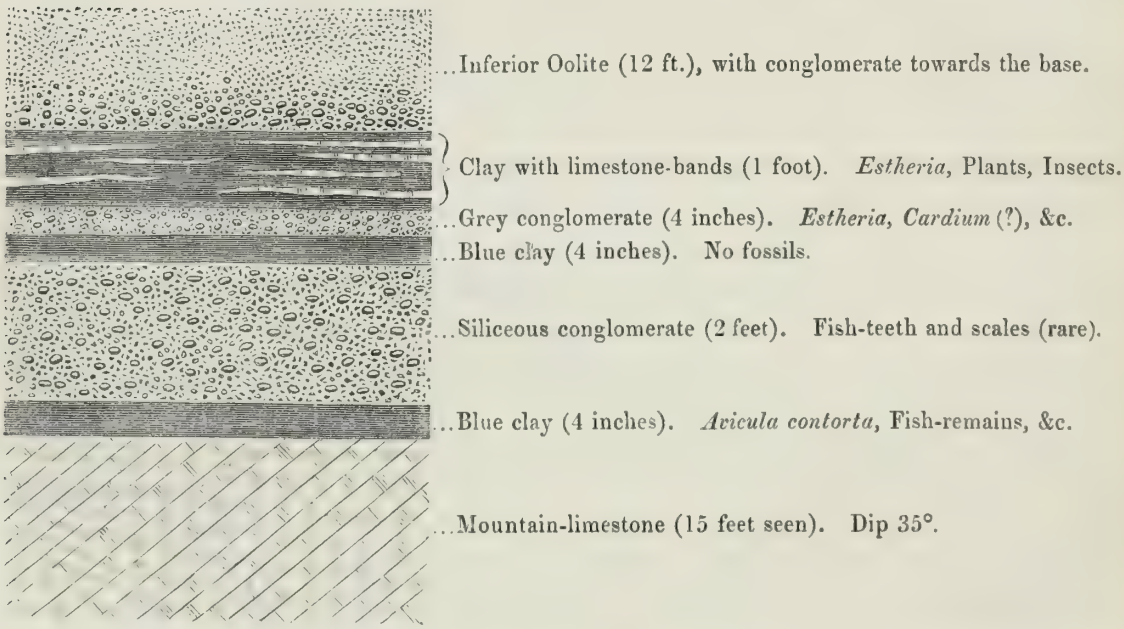
[1] At all these localities the Estheria-bed occurs at the same horizon as it does at Westbury, according to Mr. Etheridge, who has kindly assisted me in examining several specimens collected by Mr. Kirshaw and himself, in Warwickshire, and now in the Museum of the Geological Survey.

Gloucestershire, the *Avicula contorta zone*, and the *Bone-bed;* so that, were the 'White Lias' to be considered to represent a distinct formation, not less than four geological eras would be exhibited in one section of about thirty feet in depth.

"A thin band of conglomerate, one and a half inch thick, of precisely the same aspect, and the same age, is present in the Uphill railway-cutting, near Bristol."

Mr. C. Moore has lent me three specimens containing *Estheria* from the Vallis. One is a fragment of hard calcareous conglomerate, consisting of brecciated limestone (mountain-limestone?), small, oval, rounded pebbles of similar dark-coloured limestone, and a cream-coloured calcareo-argillaceous matrix, in which, besides a cast of *Cardium* (obscure), are some ill-preserved but distinct specimens of *Estheria minuta*, var. *Brodieana*, preserving, in some degree, their convexity. The other two specimens are pieces of a light-grey, laminated, calcareo-argillaceous stratum, slightly micaceous, with minute, dark, vegetable (?) specks, and rare scattered individuals of the same *Estheria*, convex and well preserved (Pl. II, fig. 8, is taken from one of these specimens). These *Estheriæ* from Frome are rather larger than those of Westbury and Wainlode.

Fig. 4.—*Section in the Vallis, near Frome, Somersetshire.*



IV. *Morayshire.*—In the Rhætic formation are included the fossiliferous shales, lying on the "cornstone" and Triassic (?) sandstone, at Linksfield, near Elgin, in Scotland.

In these beds also occurs the same variety of *Estheria minuta* as that which we find in Gloucestershire and near Frome; but it is somewhat larger than those of Wainlode and Westbury, and of a squarer and more symmetrical form; and occasionally it is less strict in its pattern of superficial ornament than is usual in either *Estheria minuta* or the var. *Brodieana*. (See Pl. II, fig. 11, and Pl. V, fig. 10.)

The late Mr. Patrick Duff favoured me (in 1860) with some specimens from his cabinet, collected probably many years ago, which consist of a hardish, greenish-grey, fine-grained, sandy, calcareo-argillaceous shale, crowded with thin, light-brown, and dark-brown *Estheriæ*, preserving but very little of their original convexity. These have here and there a reticulate ornament (such as seen in Pl. II, fig. 10), but often appear to be smooth.

Mr. S. H. Beckles, F.R.S., F.G.S., kindly procured for me, in 1861, a quantity of the Estherian shales, from Linksfield; these are also greenish-grey, calcareo-argillaceous shales, but are soft, contain fewer *Estheriæ* (which are thin, flattened, and of a light-brown colour), and are associated with similar shales full of *Cypridæ*. A few *Estheriæ* are sometimes scattered among the *Cypridæ*. The specimens here have often a boldly reticulate ornament, passing (towards the ventral edge) into short transverse bars (such as seen in the North American *Estheriæ*, Pl. II, fig. 37).

Lastly, Mr. Charles Moore, F.G.S., has lent me some specimens of green clay from Linksfield, crowded with dark-brown, crushed *Estheriæ*, having a distinct reticulate ornament (Pl. II, figs. 9—11).

The Linksfield shales of Morayshire have long been known from the careful description of them published by the late Mr. Patrick Duff, of Elgin, in his 'Sketch of the Geology of Moray,' Elgin, 8vo, 1842.

At first they were collocated with the Wealden or rather the Purbeck beds, by Dr. J. Malcolmson (see Mr. Duff's 'Geol. Moray,' p. 19, and 'Quart. Journ. Geol. Soc.,' vol. xv, pl. xi, fig. 2); Mr. Beckles[1] also, in 1858, was struck with the close lithological resemblance of the Linksfield shales to the Purbeck beds. Prof. Morris has considered these shales to represent a freshwater deposit of the Lower Oolite period (like the Brora beds), as is evident by his referring the Linksfield fossils (in his 'Catal. Brit. Fossils') to the Great Oolite. In 1860 Mr. Charles Moore ('Quarterly Journal Geological Society,' vol. xvi, p. 445) recognised a similarity of appearance between the shales and thin limestone bands at Linksfield and those of the Bone-bed (or Rhætic) series (at the base of the Lias) at Pylle Hill, near Bristol, at Aust Passage and Penarth, on the Severn, and at the Uphill cutting on the Great Western Railway, and more particularly in the presence of beds at Linksfield representing the "White Lias," the "Cotham Marble," the "Bone-bed," and the gypseous clay-bands of the Rhætic formation in the South of England. The fossils also appeared to him to support this correlation. Lastly, the Rev. W. S. Symonds, writing in 1860, refers to "the probable Liassic and Triassic character of the shales at Linksfield" ('Quart. Journ. Geol. Soc.,' vol. xvi, p. 459. See also 'Edinb. New Phil. Journ.,' New Ser., 1860, vol. xiii, p. 99).

[1] My friend Mr. Beckles kindly went to considerable expense (in 1861) to obtain for me a large series of these fossiliferous shales and limestones, especially those rich with *Cypridæ* and *Estheriæ*.

In chapter ii (pages 15—19) of the 'Geology of Moray,' these shales are thus described by Mr. Duff:

"Immediately below the drift of sand and gravel, are found, in the Eastern Division [of Moray], the Lower Purbeck beds of the Weald. These form the uppermost group of the Oolitic series; they are essentially freshwater or estuary: they consist of numerous alternate beds of grey, green, blue, and almost black layers of highly tenacious clay, between which are interposed at intervals double bands of coarse, light-green-coloured limestone, having a plain earthy fracture, which yields, when burned, a yellow powder, like peat-ashes. The uppermost limestone band is covered above by a layer of green clay, and rests on a band of whitish slate-like slabs, which, when split, present septaria of a greenish colour. To these succeed, in the descending order, beds of green and blue clay; next, a second band of limestone, which rests on a bed of dark-coloured shale, containing slabs varying from one to three inches in thickness, of a dark-grey, sparkling, highly crystallized limestone, on the upper surface of which are imbedded numerous bivalve estuary shells; and on the lower surface is a ferruginous crust, in which are found numerous scales, teeth, and spines of extinct species of sharks and pike, and bones, &c., of other animals. Through the substance also of these slabs are found fossils in abundance. The shale which contains these fossiliferous slabs appears to be composed, to the thickness of three feet, of the shelly coverings of a minute crustacean, called *Cypris globosa*, and is a striking instance of the great length of time that must have elapsed ere beds of such extent could have been formed from the exuviæ of myriads of insects whose individual size did not equal the head of a pin. Below this bed of shale are other layers of various coloured clays; the whole resting on the cornstone or limestone bed, belonging to the sandstone formation to be afterwards noticed. But between the cornstone and the Wealden beds, and pervading the surface of the lime-rock, is a bed of reddish clay, or till, four feet thick, interjected, as it were, between the Wealden beds and the cornstone. . . . . The Wealden beds occur at five different localities in the Eastern District [of Moray], viz., 1st, in the bank at the west end of the town of Elgin, on which the House of Maryhill stands. . . . . . 2nd, at Linksfield. . . . . 3rd, in a field to the westward of the House of Pitgaveny. . . . . . 4th, in a bank on which the ruins of the Castle of Spynie are situated; and 5th, in a field a little westward of Waukmill. . . . . But the most interesting locality is at Linksfield, where a series of beds, forty feet in thickness, has been cut down and removed, in order to get at the limestone below. . . . . The provincial name of these beds is, 'The Cutley Clay.' . . . . . We owe the identification of the Wealden beds of Moray with those of Sussex, to Dr. John Malcolmson, of India."

The fossils of these shales and limestone bands of Linksfield are stated by Mr. Duff to be—

Teeth, scales, and dorsal spines of *Hybodus* (*H. Lawsoni*, Duff). Teeth and scales

of *Lepidotus;* and a nearly perfect *Lepidotus* (?).[1] Teeth of *Acrodus.* Teeth of *Sphenonchus.*[2] Femur of a Chelonian animal. Vertebræ of *Plesiosaurus subconcavus,* Duff. Saurian teeth. *Mytilus, Unio, Astarte, Cyclas media, C. membranacea, Planorbis, Paludina,* and *Cypris globosa.* Fossil wood and lignite.

The late Mr. Duff most obligingly favoured me (in 1860) with specimens of the *Estheria* from Linksfield, and in February, 1861, replied most courteously to my inquiries respecting these fossils; and I learned from him that they used to be termed "Cyclas?" and "Operculum?"; and that they occur abundantly in a greenish-grey, sandy shale, rather flattened, and lying horizontally, some of them with the two valves open, and in their natural position.

The section taken at Linksfield by Mr. C. Moore, in 1860 ('Quart. Journ. Geol. Soc.,' vol. xvi, p. 446), is as follows:

	ft.	in.
1. The till or drift.		
2. Green clay. *Cypris* (rather sparingly). Teeth of *Hybodus,* and scales of *Lepidotus*	1	6
3. Grey stone. Small *Modiola*	5	0
4. Blue, variegated, and green clay. *Cypris* (rare). *Hybodus. Lepidotus*	1	6
5. Stone	1	8
6. Green clay. *Cypris. Estheria. Lepidotus, &c.*	0	10
7. Stone	0	10
8. Dark clay. *Cypris. Lepidotus. Hybodus*	0	10
9. Stone (= "Bone-bed"). Teeth and spines of *Hybodus minor.* Teeth, jaws, and scales of *Lepidotus. Sphenonchus Martini,* Ag. Teeth and vertebræ of *Plesiosaurus,* &c. Small Univalve and Bivalve shells. Remains of Plants	0	3
10. Blue clay. *Cypris,* abundant. Fish-remains, rare	4	0
11. Stone	1	4
12. Green marl (*Estheriæ* occurs in some of these lower beds)	0	9
13. Stone	0	10
14. Green marl	2	10
15. Stone	0	10
16. Green marl	2	0
17. Stone	0	8
18. Green marl	0	5
19. Boulder-clay	5	0
20. Cornstone	12	0
21. Reptiliferous Sandstones (?).		

Habitat of E. minuta, *var.* Brodieana.—In Gloucestershire, Worcestershire, and Warwickshire, the Rhætic *Estheria* occurs along a certain zone immediately above a stratum full of marine shells, which, like others belonging to this Rhætic stage, appear to be dwarfed, as if they had been the inhabitants of an unfavorable locality, or lived in sea-water under the influence of large freshwater affluents. In the Estheria-bed itself no marine shells are found. Fragments of terrestrial plants in the associated beds indicate the near proximity of the land to the waters in which these deposits were formed. Here,

[1] In Morris's 'Cat. Brit. Foss.,' 2d edit., by a misprint, "Linksfield, N.B.," is misplaced against "*L. pectinatus,*" instead of against "*L. minor* (?)."

[2] *Sphenonchus Martini,* from Linksfield, Agass., vol. iii, p. 203, t. 22*a*, figs. 15—17, is the "frontal spine" of *Hybodus,* according to Messrs. Charlesworth and Ogilby, 'Magaz. Nat. Hist.,' 1839, new ser., vol. iii, pp. 245 and 280.

as in the Keuper, we may suppose that the *Estheriæ* flourished in brackish, if not in fresh, water, at intervals when the saltness of the sea was more or less reduced by the land-waters.

The absence of *Estheriæ* in the Rhætic beds (or *Avicula contorta* zone) of Germany is coincident, apparently, with their more decidedly marine character; and so also the apparent absence of *Estheriæ* in the Triassic beds of the Alps, with their many fossiliferous strata, may be due to more constant marine conditions having obtained during the Triassic period in that area than in the Western European region.

7. Estheria Mangaliensis, spec. nov. Pl. II, figs. 16—23.

Estheria, *Hislop*. Quart. Journ. Geol. Soc., vol. x, p. 472; vol. xi, p. 371; vol. xvii, pp. 347, 353.
— *Jones*. Ibid., vol. xii, p. 377.

	Inch.	Inch.		Inch.
Height	$\frac{1}{12}$	$\frac{2\frac{1}{2}}{12}$	less than	$\frac{2}{12}$
Length, less than	$\frac{1\frac{1}{2}}{12}$	$\frac{4}{12}$	„	$\frac{2\frac{1}{4}}{12}$
Proportion	$1\frac{1}{4} : 2$	$1 : 1+$		$1 : 1\frac{1}{2}-$

Carapace-valves usually broadly subovate (fig. 16), but varying from subtriangular (fig. 20) to suboblong (fig. 21), according to age, sex (?), and state of preservation.

In fig. 20 the anterior extremity is truncate, advancing but little beyond the umbo; but usually it curves out boldly from beneath the umbo, not unfrequently with as full a curvature as that of the posterior margin (figs. 21, 23); normally, however, the valve appears to be somewhat narrower in front than behind (figs. 16, 22). The hinge-line, terminated in front by the umbo, is well marked; in the majority of specimens it is equal to rather more than half the length of the valve (figs. 16, 21); but in others it is little more than a third (figs. 20, 23).

Ridges about fifteen; but in adults they are crowded in increasing numbers towards the ventral border, and become merely the overlapping flat edges of the periodical layers of the carapace; this is well seen where the growth has been irregular, owing to some local accident (fig. 19). The interspaces are broad and smooth, presenting here and there an obscurely hexagonal reticulation of small meshes (figs. 17, 18).

A remarkable similarity exists between this fossil form found at Mángali and a recent *Estheria*, living in the pools near Jerusalem, figured and described by Dr. Baird as *E. Gihoni* ('Annal. Nat. Hist.,' ser. 3, vol. iv, p. 281, pl. v, fig. 1). The valves of the latter, however, have fewer ridges and wider interspaces; and its ornament is a far bolder reticulation than that exhibited by the fossil; were *E. Gihoni* fossilized, however, it would be with difficulty distinguished from *E. Mangaliensis*.[1]

At Mángali, in Central India, about sixty miles south of Nágpur, the Rev. Messrs.

[1] In the 'Memoirs of the Geological Survey of India,' vol. iii, p. 197, Dr. Oldham has by mistake stated that Mr. Hislop's specimens of *Estheriæ* from Mángali were identified by me with *E. minuta*.

S. Hislop and R. Hunter discovered in 1853 a fossiliferous sandstone, which is described[1] in the 'Quart. Journ. Geol. Soc.,' vol. xi, p. 370, and vol. xvii, p. 347. This sandstone extends between Mángali and Mesá, near Chickni; it is fine-grained, red in colour, somewhat argillaceous and micaceous, thin-bedded, and about fifteen feet thick, lying between an upper and a lower sandstone, both of them coarser in texture, lighter in colour, and thick-bedded. The red laminated sandstone contains Plant-remains,[2] ganoid scales and small jaws of Fishes, Labyrinthodont remains (*Brachiops laticeps*, Owen), and wide-spread, thin layers of *Estheriæ.*

From the evidence of the organic remains found in this red sandstone at Mángali and Mesá, Mr. Hislop is inclined to consider it as of the same age as the plant-bearing sandstone of Nágpur, and the coal-shales of Umret and of the south base of the Mahádewa Hills, and to refer the whole to the Upper Triassic Formation (Letter, July 19th, 1861); Messrs. Blanford and Theobald, however, of the Geological Survey of India, seem disposed to place the Mángali beds above the plant-sandstone and coal; and, as they consider the former to be probably of Permian age, the two latter they regard as at least of that age ('Quart. Journ. Geol. Soc.,' vol. xvii, pp. 347; and 'Mem. Geol. Surv. India,' vol. i, part 1, p. 82).

In a comprehensive memoir 'On the Probable Relationships of the Strata in Central and North-Eastern India' ('Memoirs Geol. Surv. India,' vol. ii, part 2, 1860, p. 333), Dr. Oldham states that "the probability would seem to be that our 'Damuda System' (true Damuda Series of the accompanying table) belongs to some portion of the Upper Palæozoic division of European geological sequence, or to the lowermost portion of the Mesozoic division. In fact, we may possibly hereafter find that it will represent that great interval indicated by the marked separation and great break between the two series in other countries."

Of Mr. Hislop's group "B" (see p. 80), Dr. Oldham would certainly take the Umret coal-series to belong to the Lower Damuda Series; he does not think that the Kotá beds of fish-bearing shales and limestone are of the same age as these, but higher in the geologic scale, in which opinion Mr. Hislop coincides. (Letter of July 19th, 1861; and 'Quart. Journ. Geol. Soc.,' vol. xviii, p. 36.)

To show at a glance the present state of opinion as to the relationships of the Indian strata above referred to, I insert a synoptical table, comprising the classifications adopted by Dr. Carter, by the Rev. Messrs. Hislop and Hunter, and by Dr. Oldham and his colleagues of the Geological Survey of India.

[1] For the particulars of the geology of the Nágpur district, in Central India, where these sandstones and other strata of great interest occur, see Mr. Hislop's memoirs in the 'Journ. Asiat. Soc. Bombay,' vol. v, pp. 58 and 148; vol. xxiv, p. 347; and in the 'Quart. Journ. Geol. Soc.,' vol. x, p. 472; vol. xi, pp. 345 and 555; and vol. xvii, p. 346, &c.

[2] *Knorria* (?) or the stem of a Conifer; *Stigmaria* (?) or the rhizome of a Fern; *Phyllotheca* (?), stems, &c.

Synoptical Table of the Lower Mesozoic and the Palæozoic Formations of Central India.

Dr. Carter.	Messrs. S. Hislop and R. Hunter.				Geological Survey of India.
I. Panná Sandstone.	Upper Sandstone Series.	Group A.	Near Nágpur, 25 feet thick; at the Mahádewa Hills, 2000 feet.	6th.	Mahádewa[1] and Lameta Series.
		Groups B and C[2]	Fish-shales, limestone, and *Estheria-shales* of Kotá.	5th.	Upper Damúda and Rájmahal Series.
			Coal-shales of Umret. Plant-sandstones of Nágpur.	4th.	Panchét Series. (*Estheria.*) True Damúda Series. (Coal-bearing.) The upper beds form the Rániganj Group. (*Reptiles.*) Lower Damúda (of Medlicot) or Bárákar Series.
			Estheria-sandstone of Mángali, with *Reptile* and *Fishes.*		
II. Kattrá Shales.	Laminated Series.		Argillaceous shales of Korhádi; track-marked.		
			Ceratodus-clay of Máledi.	3rd.	Talcheer Series. Sandstone, Conglomerate, &c., without Coal.
		Group D.	Limestone: Near Nágpur, about 100 feet thick. In Moodelaity, 310 feet thick.	2nd.	Vindyhan Series. Bundair Group. Rewah Group. Kymore Group. — Sandstone and Shale, without Coal.
III. Tará Sandstone.	Lower Sandstone Series.		Moodelaity and Bundelcund.	1st.	Sub-Kymore Series. Semri Group. Tirhowan Limestone. — Metamorphic (?) and unfossiliferous.
					Bijawur Group.

[1] Probably of Upper Cretaceous age, according to Mr. Hislop, 'Bombay Asiat. Soc. Journ.,' vol. vi, No. 21, 1861, p. 200.

[2] The arrangement of these beds has been modified in accordance with communications lately received from Mr. Hislop; but it is not yet regarded as perfect. See also Mr. Hislop's latest memoir in the 'Journ. Bombay Asiat. Soc.,' vol. vi, p. 194, &c.

Thus divided as the opinions of the Indian geologists are respecting the age of these plant-bearing and Estherian strata of Central India, I venture still to regard them as belonging to the 'Rhætic Formation,' in accordance with some suggestions which I made in 1856 ('Quart. Journ. Geol. Soc.,' vol. xii, p. 376).

Habitat.—The absence of marine-remains in the Plant-bearing and Reptiliferous sandstone of Mángali goes far to indicate the freshwater habitat of the *Estheriæ* so abundant in one of its beds.

Dr. T. Oldham, F.R.S., the Superintendent of the Geological Survey of India, has kindly and promptly forwarded to me a piece of the Estheria-bed not long since discovered by Mr. W. T. Blanford, near Panchét (pronounced Pa'cheet), five miles south of the Damuda River, and 110 miles north-west of Calcutta, in Bengal. (See 'Memoirs Geol. Survey, India,' vol. iii, part 1, pp. 132—137, and p. 197; also 'Journ. Bombay, Asiat. Soc.,' vol. vi, p. 203.) The rock is a fine-grained, yellowish-grey, sandy, micaceous shale. The *Estheriæ* are of small size, lie closely together on one plane, and, retaining no shell, or only an excessively fine film, are represented by obscure casts and moulds, of a darker tint than the matrix. A few fragmentary plant-remains lie on the same bed-plane.

The general size of the specimens is as follows—

Height .... $\frac{\frac{3}{4}}{12}$ **inch; Length**............ $\frac{1\frac{1}{4}}{12}$ **inch; Proportion** .... **1 : $1\frac{1}{2}$+**

In shape the valves appear to be subovate, with a tendency to become oblong (like fig. 21, in Pl. II). The concentric ridges are delicate and apparently numerous (about 20); but no ornament of the interspaces can be discerned even on the few valves that retain a film of shelly matter.

Altogether, judging from the materials before me, I have no grounds for deciding whether this *Estheria* from Panchét is or is not the same as that from Mángali, some of the smaller forms of which it seems to resemble, as already suggested by Hislop and Oldham ('Journ. Bombay Asiat. Soc.,' vol. vi, p. 203).

8. Estheria Kotahensis, Spec. Nov. Pl. II, figs. 24, 25.

Estheria, *Hislop*. Quart. Journ. Geol. Soc., vol. xvii, p. 348.; Journ. Bombay Asiat. Soc., vol. vi, p. 201.

$$\left.\begin{array}{l}\text{Height, more than } \frac{1\frac{3}{4}}{12} \text{ inch} \\ \text{Length.............. } \frac{1\frac{3}{4}}{12} \text{ ,,}\end{array}\right\}\text{Proportion 1 to } 1\tfrac{1}{4}+$$

Estheriæ have been found by the Rev. Mr. Hislop in a light-coloured shale at Kotá

(or Kotah), on the Pranhítá, together with ganoid Fishes (*Lepidotus Deccanensis*), *Cypridæ*,[1] Insects, *Unio* (?) and some Plant-remains.

These *Estheriæ* occur as very thin, light-brown, compressed, and often ragged carapace-valves, in a whitish calcareous shale, thickly crowded on the thin laminæ, and associated with a layer of *Cypridæ* (see Appendix, Pl. V, fig. 25), and minute, straight, black, fibrous lines, probably of vegetable origin, lying horizontally in every direction throughout the shale. Small fragments of a Fern (*Glossopteris* ?) also occur in the shale. The *Estheriæ* are much smaller than the generality of those in the sandstone of Mángali (figs. 16 and 20), but have a round-ended oblong outline not unlike that of some individuals from this locality[2] (compare figs. 21 and 24). The surface of the valves exhibits, under the microscope, about ten delicate, concentric ridges, separated by interspaces usually smooth, or traversed by faint lines parallel to the ridges, but occasionally ornamented towards the ventral border by a pattern consisting of slight, vertical, anastomosing wrinkles, with accompanying rows of minute pits (fig. 25, magn. 100 diam.) No such ornament as this is traceable in any of our numerous individuals of *E. Mangaliensis*, nor do the latter show the faint concentric striæ of the interspaces, but either a blank smoothness or an obscurely hexagonal reticulation (figs. 17, 18). Although *Estheriæ* having a reticulate ornament do sometimes take on a transversely barred or wrinkled pattern also (as in *E. ovata*, *E. Murchisoniæ*, *E. minuta* var. *Brodieana* (of Linksfield), &c. yet the latter may be the essential and sole ornament of a species (as in *E. elliptica*); and this may be the case here.

In its different style of ornament, therefore, as well as in its fewer ridges, squarer outline, smaller size, and thinner valves, the *Estheria* from Kotá differs considerably from *E. Mangaliensis*.

The Fish-shale, limestone, and Estherian shale of Kotá[3] are regarded by Mr. Hislop as of Lower Jurassic (Liassic) age, and as lying above a sandstone, with plant-remains, probably equivalent to the plant-bearing sandstone of Nágpur (Letter, July 19th, 1861), and the latter is on the geological horizon of the "Damuda group," of Bengal (See the Table, page 80).

[1] *Cypridæ* are also found (generally compressed) in the bituminous shales of Kotá, in which *Lepidotus Deccanensis*, *L. longiceps*, and *L. breviceps* occur, with Plant-stems and *Glossopteris* (?). In the limestone at Kotá, Fish-remains (*Æchmodus Egertoni* and *Lepidotus*) occur; also Teleosaurian remains, *Sphenopteris*, &c., 'Bombay Asiat. Soc. Journ.,' vol. vi, p. 201.

[2] Hence I was at first led to regard the two forms as probably belonging to the same species. Op. cit., pp. 348 and 353.

[3] For notices of the Fish-shales and limestone of Kotá, see 'Quart. Journ. Geol. Soc.,' vol. vii, p. 272; viii, p. 231; ix, p. 351; x, p. 371; and xvii, p. 36; also 'Journ. Bombay Asiat. Soc.,' vol. vi, p. 201.

The following is the section at Kotá, on the Pranhítá.

Iron-banded sandstone of the neighbouring hills, 50—500 feet and upwards in height, covered by conglomerate.

Ft.	in.		Ft.	in.
		Regur or cotton-soil } Superficial deposits	15	6
		Clay } Superficial deposits	1	0
9	0	Limestone	9	1
6	0	Bituminous shale	0	$0\frac{3}{4}$
		Argillaceous limestone	1	0
		Bituminous shale	0	4
		Fibrous carbonate of lime, impure limestone, and blue clay-rock	0	8
		Bituminous shale	2	1
		Impure limestone	1	9
8	0	Laminated sandstone, blue clay, and shale	8	$0\frac{3}{4}$
11	8	Bituminous shale	1	6
		Fibrous carbonate of lime	0	1
		Bituminous shale	1	$3\frac{1}{2}$
		Impure limestone	5	$3\frac{1}{4}$
		Black clay, containing sand	3	6
23	0	Limestone	23	0
25	0	Blue clay } (= Green Shales of Korha*d*i?)	7	6
		Limestone } (= Green Shales of Korha*d*i?)	2	0
		Shale and clay } (= Green Shales of Korha*d*i?)	1	9
		Limestone } (= Green Shales of Korha*d*i?)	1	8
		Clay and shale } (= Green Shales of Korha*d*i?)	12	0
27	0	Red clay (= Red Clays of Korha*d*i?)	27	0
		Limestone.		
		Argillaceous sandstone (at Sironchá or Chiranjá, six miles down the river) [= the Silewa*d*a plant-sandstone, near Nágpur = Damuda group of Bengal].		

Mr. Hislop has also obtained *Estheriæ* similar to those of Kotá from Kátanapali, about fifteen miles north of Kotá. "Here the argillaceous limestone is about eight feet deep, thick-bedded above, more fissile below; and still lower down passing into white laminated strata, as at Kotá. The slaty limestone abounds with scales of *Lepidotus*, and the underlying white shale with *Estheria*." ('Bombay Asiatic Soc. Journ.,' 1862, vol. vi, p. 201.)

I may here mention that in the seventh volume of D'Archiac's 'Histoire des Progrès de Géologie' (p. 624, &c.), the reader will find a *résumé* of all that was known about the "Jurassic Freshwater Basin of Central India" down to the date of that volume.

Habitat.—None of the organic remains yielded by the Kotá beds above referred to have marine characters, if we except the Lepidoid Fishes as doubtful evidence. The *Cypridæ* associated here with the *Estheriæ* are such as live in fresh water at the present day. (See Appendix.)

9. ESTHERIA OVATA, *Lea*, sp. Plate II, figs. 26—38.

POSIDONOMYA MINUTA (*Bronn*), *W. B. Rogers.* Proc. Acad. Nat. Sc. Philad., 1843, vol. i, p. 249; POSIDONIA, sp.? Proc. Boston Soc. Nat. Hist., 1854, vol. v, p. 14.

— (?), *Lyell.* Quart. Journ. Geol. Soc., 1847, vol. iii, p. 274, fig. 6.

POSIDONIA OVATA, *Lea.* Proc. Acad. Nat. Sc. Philad, 1856, vol. viii, p. 77.

— PARVA, *Lea.* Ibid.

— OVALIS, *Emmons.* Geol. Rep. North Carolina, 1856, p. 323, fig. W., 1 and 2; Amer. Geol., part VI, 1857, p. 40, fig. 12; Manual Geol., 2nd edit., 1860, p. 191, fig. 166, 3.

— MULTICOSTATA, *Emmons.* Geol. Rep. N. Carolina, 1856, p. 337, fig. X; Amer. Geol., part VI, 1857, p. 134, fig. 103; Manual of Geol., 2nd edit., 1860, p. 191, fig. 166, 4.

— TRIANGULARIS, *Emmons.* Geol. Rep. N. Carolina, p. 338, fig. V; Amer. Geol., part VI, p. 134, fig. 104.

	Inch.	Inch.		Inch.	Inch.	Inch.
Height,	...... $\frac{\frac{3}{4}}{12}$	...... $\frac{1}{12}$	... less than	...... $\frac{3}{12}$	... more than $\frac{2}{12}$	... more than $\frac{2\frac{1}{2}}{12}$
Length,	...... $\frac{1}{12}$	...... $\frac{1\frac{1}{2}}{12}$	...... ,,	...... $\frac{4}{12}$	... less than $\frac{3}{12}$	... less than $\frac{4}{12}$
Proportion...	1 : $1\frac{1}{4}$	... 1 : $1\frac{1}{2}$	....	1 : $1\frac{1}{4}$+	.... 1 : $1\frac{1}{3}$+	.... 1 : $1\frac{1}{2}$—

Carapace-valves broadly subovate, almost semicircular; the straight dorsal line reaches across the valve, the extremities curving suddenly downwards; the postero-dorsal angle being the sharper of the two. The front and posterior margins are nearly equally rounded, but the valve is usually deepest at the anterior third, in a line with the umbo; the well-curved ventral border being rather more oblique posteriorly than anteriorly. The concentric ridges are about fifteen in fig. 26; about twenty-eight in fig. 27; and much more numerous in fig. 28. In fig. 27 we see the gradual crowding of minor concentric ridges towards the ventral border in an adult specimen, and in fig. 28 we have an individual in which, owing to some peculiarity of growth, the ridges are too numerous to be very distinct, and are unaccompanied with any ornament of the interspaces (figs. 29, 30). In other specimens we find, besides blank surfaces (fig. 31), modifications of a reticulate ornament on the interspaces (figs. 32—36), with occasionally a barred or transversely wrinkled pattern (figs. 37, 38). Fig. 31 is a set of narrow interspaces, smooth and without ornament. Fig. 32 shows how a smooth surface may mask the reticulate structure. Figs. 33, 34, 35, and 36 are reticulate interspaces, the meshes being of various sizes and arranged either longitudinally, diagonally, or vertically. In the first case the walls of the meshes would strengthen, if not give rise to, minor concentric striæ; in the last case they may give rise to the bar-ornament, such as is seen in fig. 37. The obliquity of the meshes in fig. 35 may be due to pressure. Fig. 38 seems to show narrow interspaces bounded by thick ridges and crossed by short, thick bars.

For most of these illustrations[1] we have had recourse to specimens from Pennsylvania, Richmond, and Dan River (from Prof. W. B. Rogers' collection), which evidently belong to the same species. These specimens are—

1. From Pennsylvania. Black shale. *Estheriæ* excessively crowded in horizontal layers.
2. From Prince Edward, near Richmond, Virginia. Black shale, with conchoidal fracture, fine-grained. *Estheriæ* tolerably well preserved, but crumpled.
3. From Dan River, North Carolina. Black, laminated shale, obliquely crushed. *Estheriæ* very thin.

Another specimen (from which figs. 28—30 have been taken) is a hard, dark-grey, stony shale, containing a few scattered *Estheriæ* and a fragment of *Equisetites*, brought from Hardin's pit, Richmond, Virginia, by Sir C. Lyell.

As in India so in North America there are fossiliferous and coal-bearing shales and sandstones, the geological age of which is far from being exactly known; these are the plant-bearing beds of Eastern Virginia and North Carolina, with the Estherian shales of the same States and of Pennsylvania, usually known as the Middle and Lower Secondary, or Lower Mesozoic, coal and sandstones of the Atlantic slope. I propose to refer these interesting strata to the *Rhætic* formation while treating of their fossil *Estheriæ*.

In 1843, Prof. W. B. Rogers discovered in Prince Edward County, Virginia, a little fossil which he referred to the European *Posidonomya minuta* ('Proceed. Acad. Nat. Science, Philadelphia,' vol. i, p. 249); and in 1854 ('Proceed. Boston Soc. Nat. Hist.,' 1856, vol. v, p. 14), in treating of the close relationship of the several tracts of the "Middle Secondary Rocks" of North Carolina, Virginia, Pennsylvania, and Massachusetts, and of their probable Jurassic age, he again alluded to this little fossil, but pointed out that both it and another form associated with it "differ in proportion from the *P. minuta* of the European Trias." According to Prof. W. B. Rogers, the "Posidoniæ" of North Carolina (Dan River) "were noticed as early as 1839, by Dr. G. W. Boyd, while on the Virginia Geological Survey," 'Proc. Boston Soc. N. H.,' vol. v, p. 16.

In 1847, Sir. C. Lyell described and figured two apparently well-conditioned *Estheriæ* from the Mesozoic coal-shale of Richmond, Virginia, 'Quart. Journ. Geol. Soc.,' vol. iii, p. 274 (fig. 6); but unfortunately the specimens cannot now be found.[2] The woodcut, though good, does not furnish sufficiently exact evidence of the superficial sculpturing of the shell to enable me to compare it satisfactorily with my own material, though fig. 28 supplies its place to some extent. In this paper Sir C. Lyell stated (p. 275) that he shared Mr. Morris's doubts as to whether the "Posidonomyæ" from Richmond, as well

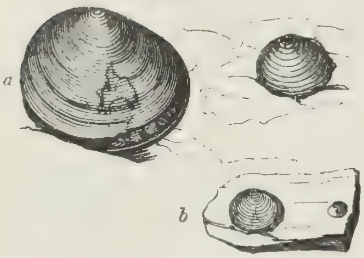
[1] Since these illustrations were drawn and the accompanying text placed in the printer's hands, I have received through Mr. C. Wheatley's liberal kindness a large collection of the Estherian and Cypridiferous shales from Phœnixville; and some notes on these will be appended in the sequel.

[2] These *Estheriæ* are also figured in Lyell's 'Manual of Geology,' 5th edit., p. 332, fig. 422, *a*, *b*.

as the "Posidonomya minuta," may not be allied to *Cypris* rather than to any genus of the Mollusca.

The larger form figured by Lyell (fig. 6 *a*, here copied as fig. 5 *a*) is stated to resemble *Cyclas* in outline; oval and inequilateral; $\frac{6}{20}$ths inch in diameter. It was from Hardin's pit, north of Blackheath, near Richmond, Eastern Virginia.

Fig. 5.



Estheria ovata, *from Richmond. Magnified and of natural size. After Lyell.*

The smaller one (fig. 6 *b*, here copied as fig. 5 *b*), $\frac{2}{20}$ths inch in diameter, is described as being more convex than the other; "resembles a young *Astarte*, but may perhaps be the young of the preceding." From Hardin's pit, and also from Creek mines, south of Blackheath, Virginia.

The same fossils were found at the Deep-run pits, at the northern extremity of the coal-field. "They occur in such immense numbers (at Blackheath) as to divide the shale, like plates of mica, into very thin laminæ. Every fresh surface exhibits a layer of them."

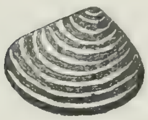
In 1856 Dr. I. Lea read before the Academy of Natural Sciences of Philadelphia,[1] some notes on the "New Red Sandstone Formation of Pennsylvania," and stated that in the greenish and blackish shales near Phœnixville, on the Schuylkill, he found two forms of "Posidonia" (*Estheria*) both differing apparently from those figured by Sir C. Lyell; and he named them the *P. ovata* and *P. parva*, "the first being about $\frac{7}{20}$ths of an inch in transverse diameter; the latter more rotund, and about $\frac{3}{20}$ths of an inch in transverse diameter."

Fig. 6.

Estheria ovata (P. multicostata, *Emmons*), *from North Carolina, magnified. After Emmons.*

Prof. E. Emmons in his 'Geolog. Report of North Carolina,' 1856,[2] p. 337, describes and figures two forms of *Estheria* as *Posidonia multicostata* and *P. triangularis* from the upper portion of the Deep River series in Chatham Co., North Carolina. According to Mr. Conrad,[3] the former of these "had previously been indicated by Mr. Lea under the name of *P. ovata* from specimens obtained at Phœnixville; and probably the latter was also indicated under the name of *P. parva* from smaller specimens than those presented this evening, but likewise obtained from the same locality."

Fig. 7.



Estheria ovata (P. triangularis, *Emmons*), *from North Carolina, magnified. After Emmons.*

The two *Estheriæ* above alluded to are figured and described

[1] 'Proceed.,' vol. viii, p. 77.

[2] In Silliman's 'Americ. Journ. Sc.,' new series, vol. xxiv, p. 427, is a notice of Emmons's 'Geological Report of the Midland Counties of North Carolina,' 1856, with remarks by Professor O. Heer on the Plants noticed in it.

[3] 'Proceed. Acad. Nat. Sciences Philadelphia,' for 1857, p. 150.

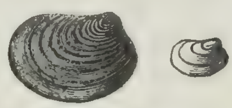
by Prof. E. Emmons in his 'Geol. Report of North Carolina,' 1856, pp. 337, 338, and in his 'American Geology,' part VI, 1857, p. 134. They are from the upper part of the Deep River series (referred by him to the Upper Trias), and occur abundantly six or seven miles south of McInvess.

E. multicostata[1] (here copied as fig. 6), $\frac{5\frac{1}{2}}{20}$ths inch in length, is described as being oval, hinge-line nearly straight; ribs fine, about twenty; similar to an *Edmondia* in shape. ('Geol. Report,' 1856, p. 337, fig. 10.)

E. triangularis (no indication of size given) has the triangular form of *Astarte* (copied here as fig. 7); shell thin; ribs strong and distant, with concave grooves between. ('Geol. Report,' 1856, p. 338, fig. 5.) These occur in company "near the top of the upper red sandstone and marls (Keuper), about seven miles south of Egypt. In these upper beds there are *Cyprides* also, which are quite numerous upon certain soft red layers."

In his 'American Geology,' part VI, 1857, p. 40, Prof. E. Emmons, treating of the animal remains from the shales of the Chatham Series (referred by him to the Lower Permian formation), describes an *Estheria* under the name of *Posidonia ovalis* (previously noticed by him in his 'Geological Report on North Carolina,' 1856[2]), and illustrates it by a woodcut (fig. 12, copied here as fig. 8). It is $\frac{6}{20}$ths of an inch long, thin-shelled, ovate.[3] He says (p. 41) "It is very common. It extends through the series of slates, but I have not observed it in the green magnesian marls. It is also common in the shales of the Richmond basin. Sir Charles Lyell has figured much larger kinds than any which I have seen either in the Deep or Dan River coal-fields." Two or three other little bivalve shells, possibly *Estheriæ*, are also alluded to in the same page; and one of them is figured (fig. 13).

FIG. 8.



Estheria ovata (P. ovalis, *Emmons*), *from North Carolina, magnified, and of natural size. After Emmons.*

To illustrate the geological position of these North America *Estheriæ*, I subjoin an account of the strata of some of the several basins of shale and sandstone, which belong to the same geological horizon as the bituminous formation of Eastern Virginia. These extend in three parallel, unequal, interrupted tracts or belts for nearly 700 miles; from Stony Point along the Hudson River to South Carolina, on the eastern border of the Appalachian or Alleghany mountains.[4]

[1] Figured also in Emmons's 'Manual of Geology,' 2nd edition, 1860, p. 191, fig. 166, 4.

[2] It is again figured in Emmons's 'Manual of Geology,' 2nd edit., 1860, p. 191, fig. 166, 3.

[3] It is figured also in this report (W. 1 and 2); and, referring it to the Mollusca, Prof. Emmons here says (p. 323) that it is the only one of the class hitherto observed in the "Chatham formation." It occurs in the "Black slates," and materially differs, according to Prof. Emmons, from that of the Upper Red Sandstone.

[4] A useful *résumé* of the history of the researches into the geology of these tracts, and of the supposed relationship of this strata, is given by Dr. I. Lea in the 'Journ. Acad. Nat. Sciences Philadelphia,' new

1. The most northern extension of the shales and sandstones under notice is exhibited in Massachusetts and Connecticut; here sandstone appears to predominate, and the well-known fossil Foot-prints of Connecticut are found in some of the beds. Fish-remains and fragments of plants have also been found; but *Estheriæ* have not been observed.

2. The second great area stretches from New Jersey, through Pennsylvania and Maryland, into Northern Virginia. In New Jersey the series consists of—1. (Uppermost) Calcareous variegated conglomerate (with Reptilian remains), and dark-red pebbly sandstone. 2. Brick-red sandstone and shales (with Footprints), and bituminous shales (with Fish-remains). Beds of coarse grey sandstone occur in the lower part of this series. *Estheriæ* have not been met with.

In Pennsylvania the following is the general order of these strata. 1. (Uppermost) Conglomerate, calcareous at places. 2. Red shale and sandstone. 3. Red sandstone and coarse yellowish conglomerates. 4. Red shale and brownish sandstone. 5. Pinkish sandstone and shale. 6. Reddish sandstone and conglomerate (locally calcareous). Prof. H. D. Rogers (whose works supply the above information for New Jersey and Pennsylvania), writing of the Pennsylvanian series,[1] says that it consists essentially of reddish-brown shales and clay, and argillaceous sandstone, in intimate alternations, but locally differing in proportions and distribution. The upper and lower parts of the series are more sandy, and have conglomerates in them, which are locally calcareous. In the middle and upper portions there are sometimes found dark-grey and blue shales, containing carbonaceous matter and some seams of lignite. A detailed section of red and bituminous shales (containing *Estheriæ* Plants, and other fossils), with sandstone, and other deposits,

series, vol. ii, part 3, 1852; and in 1858, he again gave a review of the subject in the 'Proceed. Acad. Nat. Sc. Phil.,' for 1858, p. 90; but the more exact details, and still later information, must be learnt from the works of the Brothers Rogers, Emmons, and others. D'Archiac's 'Hist. Progrès Géol.,' vol. vii, (p. 667, &c.), also contains a *résumé* of the facts and theories relating to the Mesozoic rocks of Virginia, &c. Besides the reports of the State-geologists on the several districts wherein these sandstones and shales are developed, there are numerous papers in Silliman's 'American Journ. of Science and Arts,' and in the 'Proceedings of the Boston Nat. Hist. Society,' and of the 'Philadelphia Academy of Sciences,' that elucidate the geological and palæontological characters of these Mesozoic tracts. The paper 'On the Relations of the Fossil Fishes of the Sandstone of Connecticut and other Atlantic States (or the Newark Sandstones) to the Liassic and Oolitic Periods," by W. C. Redfield, 'Amer. Journ. Sc.,' new ser., vol. xxii, p. 357, and another paper, in the 'Edinburgh New Phil. Journal,' new series, vol. v, p. 369, by Messrs. J. H. and W. C. Redfield, "On the Relation of the Post-permian Fishes of Connecticut and other Atlantic States to the Triassic and Jurassic Periods," are important in the history of the subject.

[1] 'The Geology of Pennsylvania,' &c., 4to, 1858. In vol. ii (part 2), p. 667, &c., these red shales and sandstones of "Lower Secondary Age" are treated of. Their fossils and probable place in the geological scale (Lower Jurassic, according to W. B. Rogers' latest views), are mentioned at p. 693. The relations of the several belts of these Mesozoic shales and sandstones on the Atlantic slope are treated of at p. 697. The conclusion arrived at is that the formation in question "was created in the period which unites the Triassic and Jurassic ages" (p. 697).

belonging to the Pennsylvanian series will be given further on (page 93); but I cannot indicate the exact place which these bituminous shales hold in the series.

3 and 4. Eastern Virginia. One area of carbonaceous shales and sandstones reaches from Campbell to Bucklington; another is situated on the James River, in the vicinity of Richmond. At the latter place are seen—1. (at top) Conglomerate; 2. Shales with Cycads and Ferns; 3. Grey sandstones, shales, and conglomerates; 4. Coal-seams and bituminous shale (with *Estheriæ*): altogether about 800 feet thick, and resting on granite.

5. North Carolina; on the Dan River, over a tract reaching from Leaksville to Germanton, are shales and sandstones having the following order of succession from above downwards:—

7 and 8. Grey and red marly sandstones.
6. Dark-coloured shales, with Cycads.
5. Conglomerate.
4. Grey sandstone.
3. Black and green slates[1] and coal (see section below). *Estheriæ* and *Cypridæ;* Fish-bones.
2. Brown sandstone.
1. Conglomerate.

At page 31 of Emmons's 'American Geology,' part VI, 2nd edit., from which the information respecting the Dan River and Deep River districts is obtained, the following section of the black and green shales with coal at Egypt Pit, Dan River, is given—

	Ft.	in.
Soil	30	0
Black slate, with *Cythere* [?]	16	0
Calcareous shales	12	0
Black slate, with *Cythere* [?] and *Posidonia* (*Estheria*)	25	0
Green calcareous shales	53	0
Black bituminous slates. Fossils. [Here and below "the *fossils* referred to are mostly *Cytheres* and *Posidoniæ*, and occasionally Fish-bones," p. 32]	35	0
Calcareous shales	4	0
Black bituminous slates. Fossils	45	0
Iron-balls. Gas	1	10
Black slate. Fossils	28	0
Calcareous shales	15	0
Hard black slate	13	0
Black slate and iron-balls	3	8
Sparry, calcareous, greenish shales	14	0
Black slate. Fossils	26	0

[1] "Slates" is a term used apparently by the American geologists for indurated shales (hard laminated argillaceous rock), and is not intended here to indicate real slate.

	Ft.	in.
Black slate and iron-balls	2	2
Hard sandstone	1	0
Black slate, fire-clay, and iron-balls	34	0
Black slate, beds of argillaceous iron, and balls	48	0
Sandstone	1	10
Black slate and iron-balls	1	4
Sandstone	3	0
Black slate and iron-balls	9	0
Bituminous coal	3	6
Black band	1	3
Bituminous coal	0	7
Black band	1	13
Bituminous coal	0	7
Black bituminous slate and iron-balls	8	0
Grey sandstone [saline, see Emmons, 'Amer. Geol.,' part vi, p. 96] and fire-clay	16	0
Black band	1	3
Coal	1	0
Black band	1	3
Black slate.		

6. The North and South Carolina tract, from Orange to Anson, on the Deep River. The following is the section.

Triassic, according to Emmons.

I. Red and mottled sandstones, slates, and marls, 1000 feet. *Estheriæ* and *Cypridæ;* also a Fish-scale (in a Coprolite), Saurian bones, and a Bird-bone.

H. Grey sandstone, 300—500 feet. Plants, Saurian bones.

G. Blue shale. Cycads, and other Plants } 40 feet.
F. Conglomerate, including beds of sandstone }

(There is probably an unconformity of the beds here.)

"Chatham group" (Emm.) Permian, according to Emmons.

E. Grey, thin-bedded sandstone,[1] often rippled. Fucoids. 1200 feet.

D. Bituminous shales (*Estheriæ* and *Cypridæ*), with calcareous shale, in their upper part, and comprising coal-seams and iron-stones, 700 feet. Plants, *Entomostraca, Astarte* (?), *Mytilus* (?), Fishes, Reptiles, and Mammal (*Dromatherium*).

C. Bituminous slate, alternating with grey sandstone, and passing downwards into red and brown sandstone (Coniferous Trees and Fucoids), 1000—3000 feet.

B. Conglomerate, 50—60 feet.

A. Taconic slates.

Looking at these sections (and including that of the northernmost of the areas, as seen

[1] In speaking of this sandstone, Prof. Emmons says: "When the rocks are bare in dry weather during the summer they are incrusted with a salt which consists mostly of the chloride of sodium. So also the sandstones from the Egypt Pit, at the depth of 450 feet, decompose, and a nearly pure salt effloresces upon the surface while this process is going on, yet no gypsum has been found in this series up to this time." (Page 96.)

at Greenfield, Conn.), we may observe a nearly general coincidence in the occurrence of Upper and Lower Conglomerates, which may possibly be a guide in correlating the deposits of the several areas. As little, however, has been determined strictly as to this correlation as has been fixed with regard to the exact geological age of this great group of strata.[1] Prof. E. Emmons has sketched out the members of the Deep River series (estimated at upwards of 6000 feet in thickness); he indicates two chief horizons, far apart, at which Saurian remains, Plants, *Estheriæ*, and other fossils, occur; and he believes that the distinctions of the fossils are so great, the amount of accumulated deposit so vast, and the evidence of unconformability so important, that he has reason to refer the lower portion of the series (Chatham group) to the Upper Palæozoic (Permian), and the upper portion to the Lower Mesozoic (Triassic) age respectively.

This conclusion seems to me invalid, and the palæozoic evidences are very poor indeed; but it does not concern us at present, the *Estheriæ* alone demanding special attention; and of these I have seen specimens only from Dan River, from Richmond, and from Pennsylvania, none from the Deep River series. Prof. Emmons figures a specimen from the Chatham series (*Posidonia ovalis*), and two forms from Dan River (*P. multicostata* and *P. trigonalis*). If the conglomerates in the several basins should be indicative of certain correlative horizons (as above referred to), all these *Estheriæ* would apparently belong to the same (lower) group; and the *Estheriæ* of Richmond, Va., would seem to belong to the same horizon. Prof. Emmons, however, refers the Richmond coal-field to the age of the upper part of the Deep River series (if I understand him aright).

I have not been able to discern any essential difference between the *Estheriæ* from Pennsylvania, Virginia, and Dan River (North Carolina); and they might therefore well belong to the same horizon, whatever those from the Deep River series may turn out to be. Of the latter we have figures, given by Prof. Emmons, which help us, however, little or nothing in specific determination, for I am quite prepared to say that ordinary artists and amateur draughtsmen would make as many and as variable sketches of one and the same *Estheria*, in different states of preservation, as the three given us of *P. multicostata*, *P. angularis*, and *P. ovalis*, and we will include also the far better woodcut of the Richmond *Estheria* given by Lyell. The last mentioned is equivalent to our fig. 28! Fig. 28 represents the same species as do figs. 26 and 27. And specimens of

[1] If the reader will consult Prof. H. D. Rogers's 'Essay on the Geology of the United States,' in the last edition of A. Keith Johnston's 'Physical Atlas,' he will there find the stratigraphical conditions of the Mesozoic sandstones and shales under notice amply and, I believe, correctly treated. Whatever may be the thickness of the several strata, measured perpendicularly and added together,—a thickness far surpassing, in Connecticut, according to Prof. Hitchcock, that of either the Triassic or the Jurassic strata of Europe ('Elementary Geology,' new edition, 1860, p. 409), yet, as these deposits have been formed in confined areas, and on sloping shores, it appears to me that Prof. Rogers' observations must satisfy any dynamic geologist that no great vertical displacement of the area has been required for the accumulation of this sedimentary mass in the shallow waters of the old sub-Appalachian water-belts.

the same occur sufficiently distorted, or otherwise modified, to be sketched like the rough figures, above alluded to, which are copied at pages 86 and 87.

Further, Mr. Conrad appears to have identified *P. multicostata* with *P. ovata* (Lea), and *P. triangularis* with *P. parva* (Lea); and of Lea's species we can judge by our own Pennsylvanian specimens, which agree with those from Richmond and Dan River, there being evidence of one species only.

Of *P. ovalis*, Emmons, we learn, that it is "common in the shales of the Richmond basin," as well as in the Lower (Chatham) shales of the Deep River series; and, indeed, the Dan River series is mentioned in connection with its occurrence. At all events, it appears that we may expect to find it among our Richmond specimens; and hence I believe that it merges, with the rest, into the one species which appears to have an enormous range, horizontally and vertically, in this great series of Lower Mesozoic deposits in North America.

In 1857 a few specimens of fossil *Estheriæ* from the black shales of Pennsylvania, Virginia, and North Carolina, were confided to me by the Professors W. B. and H. D. Rogers. Though some of these seemed at first sight to be tolerably well preserved, and to belong to two or even three distinct forms, yet, on examination, the difficulty of discriminating any real differences of feature and structure has been found to be very great, if not impossible. The results, however, arrived at as to the determination of species is given above.

I cannot make as full and exact a comparison of the North American fossil *Estheriæ* with those of Mángali and of other places as I should have wished; but we can learn much respecting the palæontological associates of the *Estheriæ*, and of the probable mode of the deposition of the strata in which they are found, from the accounts given of the Estherian shales of Pennsylvania by the geologists of the United States.

The *Estheriæ*, accompanied by *Cypridæ*, occur in the "Main Red Sandstone belt in Pennsylvania, Virginia, and North Carolina," in the short intermediate tract of Red Sandstone in Virginia, and in the more eastern tract in Virginia and North Carolina. Without, however, availing ourselves of the full descriptions of these strata given by Rogers,[1] Emmons,[2] and others, it will be sufficient to take the section exhibited by the cutting of a tunnel on the Reading railway at Phœnixville, Chester County, Pennsylvania, described lately by Mr. Wheatley; and this is the more interesting as the author gives a critical résumé of the reptilian and other remains found in the same group of strata, and offers some remarks on the apparent similarity of these with the Nágpur and Mángali beds. I therefore avail myself of the following communication made to the 'American Journal of Science and Arts,' 2nd ser., vol. xxxii (No. 94, July, 1861), p. 41, &c., mentioning at the

[1] 'Reports on the Geology of New Jersey, Virginia,' &c.; and especially the 'Final Report on the Geology of Pennsylvania,' 1858.

[2] 'Reports on the Geology of North Carolina,' &c., and 'American Geology,' part VI, 1857.

same time that I am indebted to Mr. Wheatley[1] for a polite reply to my inquiries respecting the section, and for an illustrative diagram (fig. 9, p. 95).

"*Remarks on the Mesozoic Red Sandstone of the Atlantic Slope, and notice of the Discovery of a Bone-bed therein, at Phœnixville, Pennsylvania.* By CHARLES M. WHEATLEY, M.A. (Read before the Connecticut Academy of Arts and Sciences, Feb. 20th, 1861.)

"No question in American geology seems more difficult of elucidation than the age and geological position of the so-called 'New Red Sandstone' of the Atlantic slope; some geologists referring it to the Oolitic or Liassic periods, others to the Trias, and others, still lower, to the Permian. The true position may probably be determined, like the San Casciano Beds, intermediate between the Liassic and Triassic periods, forming a separate group, containing, like those beds, its own peculiar fossils. No true Permian forms characteristic of that formation have yet been discovered; the fishes formerly referred to *Palæoniscus* are now placed in the genera *Catopterus* (Redfield) and *Ischypterus* (Egerton), their tails being more homocercal than heterocercal. The *Clepsysaurus* (Lea), once considered a Thecodont Saurian and analogous to *Thecodontosaurus antiquus* of Riley and Stutchbury from Redland, near Bristol, England (found in dolomitic conglomerate referred to the Permian, but now considered not older than the Triassic), is stated by Dr. Leidy ('Proc. Acad. Nat. Sci. Philad.,' June 9th, 1857) to be 'not properly a Thecodont reptile, but may form the type of a new family, as its teeth are inserted in the jaws by solid conical fangs.'.........Mr. Wheatley proceeds to correct Prof. H. D. Rogers in his distribution of the Reptilian remains ('Final Report on the Geology of Pennsylvania,' vol. ii, part 2, p. 695) said to have been found in Pennsylvania and New Jersey; and then states that "the following fossils have been noticed in the 'Mesozoic Red Sandstone' of Pennsylvania (chiefly from the shales excavated in the railway-tunnel[2] near Phœnixville.

"*Plants, Phœnixville and Gwynnedd.*

"*Equisetum columnare*, Brong., 15 to 16 in. long, and 7 in. circumference. In sandstone of a dark-grey colour, with iron-pyrites, Phœnixville.

"*Pterozamites longifolius*, Emmons. In grey micaceous sandstone, with iron-pyrites, Phœnixville.

"*Gymnocaulus alternatus*, Emmons. In light micaceous sandstone, Phœnixville. Fir-cones, 6 in. long, 1 in. wide, Isaac Lea, this Journ. [2], vol. xxii, p. 123, 1856, in black bituminous shales, Phœnixville.

"Plant resembling that figured by Emmons as *Calamites punctatus*. In black bituminous shales, Phœnixville.

"Plant resembling *Noeggerathia*, at Gwynnedd, I. Lea ('Am. Jour. of Sci.,' vol. xxii, 1856, p. 123), probably the same as figured by Emmons ('N. Car. Rep.,' pl. 1, fig. 3), as *Dictyocaulus striatus*, and which Prof. O. Heer (this Journal [2], vol. xxiv, p. 428) says 'has an obvious resemblance to *Noeggerathia*.'

"A number of plants, seed-vessels, &c., have been found in the grey micaceous sandstone and black shales at Phœnixville, the genera of which are yet undetermined.

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[1] Since this was written I have received a large supply of *Estheriæ*, and other fossils of the Phœnixville shales, from Mr. Wheatley. These will be noticed by themselves in the sequel.

[2] The position of this tunnel (Black-rock Tunnel), a little north of Phœnixville, Chester Co., is shown in the map of the mining district of Chester and Montgomery Counties, in Rogers's 'Geol. Pennsylvania,' vol. ii, part 2, between pp. 674 and 675.

"Crustacea at Phœnixville and Gwynnedd.

"*Estheria ovata* (*Posidonia ovata*, Lea) and *Estheria parva* (*Posidonia parva*, Lea), in black bituminous shales, Phœnixville (also at Gwynnedd).

"*Cypris*, two species, one smooth, the other beautifully granulate,[1] in black shales, Phœnixville, Rogers; also at Gwynnedd, J. Leidy ('Proc. Acad. Nat. Sci. Phil.,' June 16th, 1857).

"*Limulus* (?). Fragment of shield, probably *Limulus;* black bituminous shales, Phœnixville. Other remains, probably Crustacean, have been found in black shales, Phœnixville.

"Mollusc from Phœnixville.

"*Myacites Pennsylvanicus*, Conrad ('Proc. Acad. Nat. Sci. Phil.,' 1857, p. 166; and 1860, pl. 1, fig. 3). In the black shales, with *Estheriæ.*

"Fishes at Gwynnedd and Phœnixville.

"Single ganoid scale, in black bituminous shales, at Gwynnedd, Isaac Lea, this Journ. [2], vol. xxii, 123, 1856, more like *Pygopterus mandibularis*, Ag., than any other which had come under Mr. Lea's notice.

"Scales, bones, and teeth of ganoid fishes are abundant in black bituminous shales at Phœnixville. Scales have been found by Dr. Leidy and I. Lea also at Gwynnedd ('Proc. Acad. Nat. Sci. Phil.,' June 9th, 1857).

"*Turseodus acutus*, Leidy ('Proc. Acad. Nat. Sc. Phil.,' June, 1857, p. 167). 'This genus and species are founded upon a left dental bone, with teeth, probably of a ganoid Fish, which I obtained from the black shales of what have been usually considered the Triassic rocks, from near Phœnixville, Chester Co., Pa.'

"*Radiolepis speciosus*, Emmons. Family *Cœlacanthi.* Scale discovered at Gwynnedd by Isaac Lea, in black bituminous shales ('Proc. Acad. Nat. Sci. Phil.,' June 7th, 1857), also at Phœnixville.

"*Catopterus gracilis*, Redfield. Scales, bones, and teeth, similar to those from Richmond, Va., and North Carolina, are found in bituminous shales at Phœnixville.

"Reptiles at Phœnixville, &c.

"*Clepsysaurus Pennsylvanicus*, Lea ('Journ. Acad. Nat. Sci. Phil.,' new series, vol. ii, 1853, p. 185), founded on vertebræ, ribs, and teeth, discovered in calcareous conglomerate, Upper Milford Township, Lehigh County. Teeth, supposed to belong to this Reptile have been discovered by Dr. Leidy in black bituminous shales at Phœnixville ('Proc. Acad. Nat. Sci., Philad.,' 1859, p. 110).

"*Eurydorus serridens* ('Proc. Acad. Nat. Sci., Phil.' 1859, p. 110), founded on teeth, 'large size, compressed, conical, opposite acute serrulated borders,' discovered by Prof. Leidy in black bituminous shales, Phœnixville.

Composaurus —— ? Leidy ('Proc. Acad. Nat. Sci. Phil.' 1859, p. 110), founded on teeth discovered by Prof. J. Leidy in black bituminous shales at Phœnixville;—'borders without serrulations, base fluted; ...... resembles the teeth of *Composaurus* of the coal of Chatham Co., North Carolina, but nevertheless belongs to a different species.'

"*Centemodon sulcatus*, Lea ('Proc. Acad. Nat. Sci. Phil.,' vol. viii, p. 77, March, 1856), founded on a single tooth discovered by Mr. Lea in black bituminous shales at Phœnixville, described in this Journal [2], vol. xxii, p. 123. Bones and teeth, probably Batrachian, found by Dr. Leidy at Gwynnedd ('Proc. Acad. Nat. Sci. Phil.,' June 16th, 1857), in black bituminous shales; also at Phœnixville.

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[1] See also W. B. Rogers's remarks on these *Cypridæ* ('Proceed. Boston Soc. Nat. Hist.,' vol. v, p. 15, 1854).

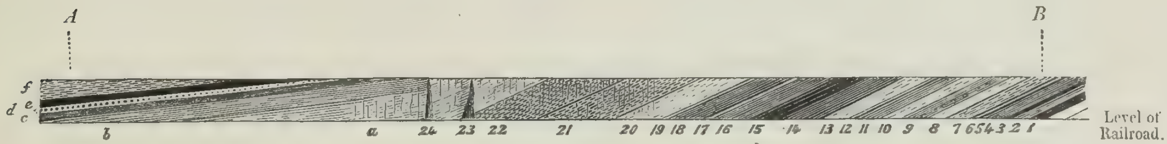
"Coprolites, very abundant in black bituminous shales at Phœnixville, some of them containing Fish-remains.

"Foot-tracks, *Chelichnus Wymanianus*, Lea, on dull-red limestone, Phœnixville, Isaac Lea ('Proc. Acad. Nat. Sci. Phil.,' viii, 77, 1856).

"Ripple-marks are also found in the red shale, Montgomery County, opposite Phœnixville."

The accompanying diagram of the strata exposed in the tunnel has been kindly supplied by Mr. C. M. Wheatley (November 23rd, 1861). The numbers in the following list of the beds correspond to those on the diagram.

FIG. 9.—*Section of the Strata in Phœnixville Tunnel, through Black Shale Hill, on the Reading Railway, Chester County, Pennsylvania.* Length of the tunnel, from *A* to *B*, 2000 feet.



A. East end of the tunnel; from hence the "Mesozoic Red Sandstone" extends about ten miles, to near Norristown; but, as far as examined, it contains no other black bituminous shales.

B. From this, the west end of the tunnel, the "Mesozoic Red Sandstone" extends about thirty miles, to near Reading; but, as far as examined, without any other bituminous shales.

a. Hereabouts is a sandstone full of Plants, and with Saurian teeth in large numbers, and bones of Saurians. From *a* towards *b* the strata are irregular. (*a*, Shale and sandstone; *b*, Red shale.)

"*Section of Strata at Phœnixville Tunnel, Pennsylvania, beginning at the eastern entrance, and running about two thirds through; dip north-west.*

	Ft.	in.
"1. Red shale	5	0
2. Green shale	6	0
3. Black bituminous shale, containing Saurian bones, coprolites in abundance, *Estheriæ*, remains of ganoid Fishes, and *Cypris;* there are clay-concretions, about 1 in. in thickness, in the upper part	1	10
4. Red and green shales, the green slightly calcareous, with traces of *Estheriæ;* and iron-pyrites	11	0
5. Black bituminous shales, with scales of ganoid Fishes, *Estheriæ*, and *Cypris;* fossils not very abundant	1	0
6. Dark-green, hard, compact shale, full of clay-concretions; traces of *Cypris*	0	9
7. Red micaceous sandstones	7	10
8. Brown sandstone, with calcite veins and quartz crystals	8	6
9. Hard, compact, red, and green shale, with nodular concretions of limonite abundantly distributed all through it, forming a hæmatitic conglomerate	5	8
10. Red sandstone, with remains of Plants	5	6
11. Red and green shale	5	2
12. Red shale, with Coprolites and Plants, the Coprolites enclosing scales of ganoid Fishes	0	10
13. Grey sandstone, with veins of carbonate of lime	5	5
14. Fine-grained, red and green, variegated shale	24	0

		Ft.	in.
15.	Black, bituminous shales, with *Estheriæ* and Fish-remains in upper part	6	0
16.	Grey, compact, fine-grained shale	11	0
17.	Olive-green shale, with red veins	1	0
18.	Red shale	7	0
19.	Clay-concretions, in three layers, 1 in. each	0	3
20.	Sandstone, with veins of dolomite and calcite in cleavage, which is quite vertical	11	3
21.	Fine-grained micaceous sandstone (estimated)	20	0
22.	Fine-grained compact sandstone (estimated)	25	0
23.	"Vug," or cavity, 5 ft. wide at bottom of tunnel, 21 ft. high, running to a point about 2 ft. above the back of tunnel, filled with red and green shales, talcose and micaceous, crushed to powder.		
24.	White talcose shale, vertical, 5 ft. wide at bottom, 4 ft. at top of tunnel.		
25.	Red shale, fine-grained, compact	6	8
a, b.	Strata very irregular for some distance. [Shale and sandstone.]		
c.	Shale, with clay-concretions and oxide of iron	0	10
d.	*Bone-bed,* full of Saurian bones; no other fossils noticed	0	6
e.	Black bituminous shale, with *Estheriæ* and Coprolites	0	6
f.	Fine-grained, hard, compact sandstone, full of stems of Plants	6	0

"The 'bone-bed' is situated about 100 ft. in the tunnel from the western end, and is not more than 6 in. thick. Fragments of Saurian bones occur rather abundantly all through the layer, but the more perfect bones are found at the bottom of the bed, where they are collected together, forming from 2 to 3 in. of the layer; a seam of white or pink carbonate of lime underlies them, and is from $\frac{1}{8}$ to $\frac{1}{2}$in. in thickness. Under this is a very thin seam of black carbonaceous matter, which is grooved and polished like 'Slickensides,' evidently showing [the action of] great disturbing force since the deposition of the bed.

"The material composing the bone-bed is formed almost entirely of the remains of *Cypris*. No Estherias Myacites, Coprolites, nor Fish-remains have been observed associated with the Saurian bones in many tons of the shale carefully broken up and examined.

"Above the bone-bed is about 6 in. of bituminous shale with *Estheriæ* and Coprolites; over this from 5 to 6 ft. of hard, fine-grained sandstone, with Plants. The bed (bone-bed) is underlaid by 10 in. of shale with clay-concretions, which are mostly geodes, containing yellow, pulverulent oxide of iron, and under this a compact, fine-grained, red shale, from 6 to 7 ft. to the bottom of the tunnel.

"Near the above, in a micaceous dolomitic sandstone, of a light-grey colour, occasionally so calcareous as to effervesce freely in acids, occur Saurian bones, and part of a jaw, 7 in. in length, $\frac{7}{10}$ in. wide, and about $\frac{8}{10}$ in. deep, with seven alveoles about $\frac{3}{10}$ in. apart,—a cranial plate, radiated and sculptured, $1\frac{1}{2}$ in. long and $1\frac{2}{10}$ in. broad,—an Ichthyodorulite, 3 in. long $\frac{3}{10}$ in. wide at base,—remains, probably, of Batrachians,—*Estheriæ,*—and bones, scales, and teeth of ganoid Fishes; the scales are large, thick, beautifully ornamented, and coated with a layer of transparent enamel (ganoin).

"Casts of two shells; one may probably be referred to either *Pholadomya* or *Cardita*, and the other to *Unio* or *Potomomya*, and also large quantities of Saurian teeth, some of which are full $1\frac{1}{2}$ in. in length, curved, smooth, or finely striated, probably belonging to *Clepsysaurus Pennsylvanicus*, Lea; others curved and sulcate, and answering to the description of *Centemodon sulcatus*, Lea. Another, perhaps, may be *Composaurus*, Leidy, and another of 'large size, compressed, conical, with opposite acute, serrulated borders,' which doubtless is that described by Prof. Leidy as *Eurydorus serridens*. These teeth are found twenty or thirty together, and are well preserved; sometimes the teeth are converted into iron-pyrites for one half their length, or the pulp-cavity alone filled with pyrites; and occasionally small seams of dolomite, calcite,

or sulphuret of iron, cross them transversely without disturbing their position. It is remarkable that, while the black bituminous shales have afforded but few Saurian teeth, and none have as yet been discovered in the 'bone-bed,' so many should have been collected together and deposited in this stratum of dolomitic sandstone as to give it the appearance of an osseous conglomerate or a bone-breccia.

"In some instances the casts only of the teeth remain, the substance of the tooth being converted into dolomite, but retaining the exact form of the tooth, with the sulcations as distinct as in the original. Twenty teeth, of probably three or four genera of Saurians, all converted into dolomite, occur on a piece of sandstone 6 by 3 in. It is a singular fact that, while the teeth are dolomitic casts only, the bones in the same stone remain unchanged, retaining their original structure.

"Associated with the above fossils in the sandstones are numerous Plant-remains, mostly of a broad sulcated stem, without joints or branches; as far as noticed, they retain the same width their entire length, and are from $\frac{1}{2}$ to 2 in. broad and from 6 to 8 in. long.

"The shales, sandstones, and fossils of the Phœnixville Tunnel bear a remarkable resemblance to those of Nagpur and Mangali, Central India, described by Messrs. Hislop and Hunter ('Quart. Journ. Geol. Soc.,' vol. x, p. 472, and vol. xi, p. 371, 1854), and referred by them [at that time] to the Lower Jurassic age. The following is the descending order of the series according to the observations of the authors:

"1. Soft ferruginous sandstone, sometimes hard, with iron-bands and Plants.

"2. Fine and coarse argillaceous sandstones, rich with Plant-remains; these have afforded—

"Labyrinthodont reptile, *Brachyops laticeps*, Owen.
"Fishes; ganoid scales and small jaws.
"Crustaceans; *Estheria.*
"Plant-remains: Fruits and seeds, numerous and undescribed; Leaves, Conifers, Zamites, Poacites, and Ferns (*Pecopteris, Glossopteris, Tæniopteris, Cyclopteris, Sphenopteris*); Stems, exogenous and endogenous; Acrogens, *Aphyllum, Equisetites, Phyllotheca, Vertebraria* (?).

"3. Red shales 50 ft., green shales 30 ft. In the former of these there were observed at Korbádi—

"Reptilian foot-tracks.
"Worm-tracks, and intestine-shaped evacuations; these were also found in the green shales.
"*Phyllotheca* (?).

"4. White and coloured dolomitic limestones.

[There are also in some parts of the above series—]

"Bituminous shales with fossils, [and] sandstone.
"Indurated green clay-stone, green shale, [and] bituminous shale with fossils.

"The Plant-bearing sandstone of Phœnixville Tunnel, though not containing all the genera of Plants found in the [Nagpur and] Mangali strata, is far richer in Saurian remains, Crustaceans (*Estheria* and *Cypris*), parts of Ganoid Fishes, and Shells. The green shales of the tunnel have Worm-tracks and the intestine-shaped evacuations. The bituminous shales are rich in organic remains. The remains of *Coniferæ, Zamites, Equisetites*, and probably fruits and seeds, with dolomitic sandstones, indicate a very great similarity with the Lower Jurassic Central Indian formation." (See above, pages 79, &c.)

Habitat of Estheria ovata.—The fossil *Estheriæ* of North America, as far as I can learn, have no marine associates (omitting the Fishes, for reasons already given), except the little *Myacites Pennsylvanicus* and another, which are sufficiently obscure to be left unregarded. The *Cypridæ* associated with the *Estheriæ* at Richmond and elsewhere are like our recent *Candonæ*, and may well be supposed to have lived in fresh water. (See Appendix.) The long, narrow areas within which the Estherian and carbonaceous shales of the Atlantic slope were deposited may be regarded as having probably been favorable for the development of freshwater and brackish lagoons, rather than for sea-creeks freely open to the ocean (Rogers).

There is evidence of the presence of salt in some of the sandstones forming part of these Lower Mesozoic series of coal-bearing sandstones and shales. But these saline sandstones are above and below the zones of *Estheriæ* (according to Emmons), with considerable thicknesses of beds intervening (see above, page 90).

Estheria ovata from Phœnixville, Pennsylvania.—The collection of Estherian shales forwarded from Pennsylvania in May last, by Mr. C. M. Wheatley, in courteous compliance with my request to be supplied with some good material for this Monograph from the tunnel near Phœnixville, comprises a large number of specimens of black, grey, purple, and green shales, often crowded with *Estheriæ;* but the carapaces are rarely in a sufficiently good state of preservation to yield the desired information respecting their shape and ornament, far less their structure. Besides the common broadly ovate form of carapace-valve, such as appears to be characteristic of *E. ovata* (see Pl. II, figs. 26—28), and many individuals of smaller size and with thickly crowded ridges, I find among Mr. Wheatley's specimens a few of a *narrower* form, somewhat resembling the Indian specimen figured in Pl. II, fig. 16. These narrower and longer carapaces probably differ from the others merely as individuals, and can scarcely be regarded as indicating a variety, certainly not a distinct species. Indeed their shape may be due to oblique pressure, or to the imperfect exposure of the margins, in these hardened and much crushed shales. Such as these have, in all probability, been the foundation of Prof. Emmons's *E. multicostata* and *E. ovalis*, above referred to (pp. 86, 87).

The sizes of different specimens of *Estheriæ* from Phœnixville are as follows:

	Broad forms.			Narrow forms.	
Height	$\frac{1}{10}$ inch.[1]	$\frac{8}{32}$ inch.	$\frac{3}{12}$ inch.	$\frac{7}{32}$ inch.	$\frac{8}{32}$ inch.[2]
Length	$\frac{1}{8}$,,	$\frac{10}{32}$,,	$\frac{4}{12}$,,	$\frac{10}{32}$,,	$\frac{14}{32}$,,

[1] These small individuals are thickly striated with their numerous fine ridges, and appear to me to differ from the larger individuals in having lived under conditions less favorable to their growth.

[2] The individual here measured is possibly somewhat imperfect on the ventral edge, and may therefore have been a little higher (broader) originally.

The specimens of shale have the following characters:

1. Hard, black shale (sometimes breaking up rhomboidally), fine-grained and micaceous, with shining, black, filmy carapace-valves of *E. ovata* on the planes of bedding. One specimen has the large form of carapace on one plane, and small, thickly striated individuals on another.

2. Hard, black shale, like the above, with a zone of *Cypridæ*, and with an individual having the *narrow* form of *E. ovata*.

3. Hard, black shale, granular with *Cypridæ*, being almost entirely made up of these little Entomostracans; containing also Coprolites (of Saurians?), and shining, black, filmy, crumpled valves of *E. ovata* on the bed-planes.

4. Hard, dark-grey shale (weathering rusty on the planes of bedding), containing small individuals of *E. ovata*, finely striated by their numerous, crowded ridges; those on one plane are almost squeezed away, those on the other retain black remains of their carapaces.

5. Hard, dark-grey shale. Three thin bands of the dark, hornlike carapaces of *E. ovata* crop out on a sloping edge (weathering olive-coloured); besides the crowded layers, fragments of valves are scattered between. Though apparently well preserved, these carapaces show no good traces of sculpturing or structure.

6. A similar shale, bearing a largish individual, with the *narrow* outline.

7 and 8. Purple-grey shale (weathering ferruginous), and greenish-grey hard shale (weathering light olive-green), containing a few of the smaller individuals of *E. ovata*, with crowded ridges, on the bed-planes.

9. Green shale, with *Estheriæ* similar to those in Nos. 7 and 8, but showing the vertical bar-ornament figured in Pl. II, fig. 37. An important link is here supplied between these small *Estheriæ* and the larger form of *E. ovata*, their relatively small size and the crowding of their ridges alone remaining as distinctions. If living under disadvantageous circumstances, a usually large carapace might be stunted in growth, and its periodical peripheral additions would be small; producing features such as we have in this case.

In his 'Hist. des Progrès de la Géologie,' vol. viii, 1860, M. le Vicomte d'Archiac has embodied all the information down to 1859 respecting the Lower Mesozoic sandstones and shales of Massachusetts, Connecticut, New Jersey, Virginia, &c., under the heading "Formation Triasique," pp. 609—633; and here I may supply the references to the same valuable work, that I inadvertently omitted when treating of *Estheria minuta*. The Triassic formation of Würtemberg and other parts of Germany are described at pp. 426—549 of the same volume (viii, 1860); those of Alsace, at pp. 134—149; and those of England at pp. 16—50; and the strata of Rhone Hill, Tyrone, whence *E. Portlockii* was derived, are treated of at p. 12.

M. d'Archiac, in speaking of the Triassic period, in his masterly *résumé* of all that had been done towards its elucidation (1860), remarks that, of the several geological formations, the Triassic is one of the most curious to study—one of those which most strongly interests the naturalist, as much by the variety of the inorganic phenomena connected with its origin as by the singular distribution of organized beings which then peopled the earth. I must here express a hope that in the study of the history and relations of these most interesting deposits some aid will be found in the foregoing pages, treating of *Estheria minuta* of the true Trias, of its variety *Brodieana* in the Rhætic beds, and of the Lower Mesozoic *Estheriæ* of India and North America.

10. ESTHERIA MURCHISONIÆ, spec. nov. Pl. III, figs. 1—12.

TELLINA (?), *Murchison.* Transact. Geol. Soc., 2nd ser., 1827, vol. ii, p. 311.

	Inch.			Inch.	
Height	$\frac{2\frac{1}{4}}{12}$	Proportion 27 to 42, or 1 : $1\frac{1}{2}$+.	Height, more than	$\frac{4}{12}$	Proportion 17 to 33, or 1 : 2—.
Length	$\frac{3\frac{1}{2}}{12}$		Length	$\frac{5\frac{1}{2}}{12}$	

Carapace-valve nearly elliptical, the straight hinge-line interfering with the symmetry of the outline. The umbo is forward, at the end of the hinge-line, and scarcely affects the outline. The anterior extremity has a flatter curve than the posterior. About eighteen delicate concentric ridges are usually distinctly to be observed, with their rather wide interspaces (figs. 1, 3, 4, 5, &c.); but some carapaces have nearly thirty ridges, with very narrow interspaces (figs. 2, 6, 7). The ornament of the interspaces is essentially a bold, irregularly hexagonal reticulation (figs. 5 and 12), like that of *E. minuta* (Pl. II, fig. 3); but it generally takes on (or passes into) a distinct, short, vertical wrinkling at the lower part of the interspace (figs. 5, 7, 11). This sometimes presents the modification seen in figs. 3 and 8, where the wrinkling is of a much smaller pattern, and reaches half way up, or all across, the interspace. Sometimes a delicate, horizontal wrinkling interferes with (fig. 4), or replaces (fig. 9) the vertical wrinkles, without hiding altogether the reticulate structure of the shell. Not unfrequently, both the broad and the narrow interspaces are blank (figs. 6 and 10).

The carapace-valves of this beautiful *Estheria* have been converted into calcite, but are otherwise little altered by fossilization, except being somewhat compressed and rendered silvery white, and will bear comparison with the carapaces of any recent *Estheria.* Nor have we far to seek for a modern representative of this Jurassic form. *E. Dahalacensis,* Durckh. (from the freshwater marshes of the Island Dahalac, Abyssinia), figured and described by Dr. Baird, 'Zool. Soc. Proceed.,' 1849, p. 89; *Annulosa,* pl. 17, figs. 2—4, has but a trifling difference in the outline and the number of ridges; and its reticulate ornament is the same as that of *E. Murchisoniæ,* except that the tendency to develope the vertical wrinkles seems to be wanting. But the latter ornament, associated with the reticulation, just as in *E. Murchisoniæ,* is beautifully shown in a somewhat differently shaped *Estheria* from India (*E. Boysii,* Baird, 'Proc. Zool. Soc.,' 1839, p. 89, *Annulosa,* pl. 11, fig. 6).

In the Museum of the Geological Society, among a collection of fossils brought from the Western Islands of Scotland by Sir Roderick Murchison in 1827, is a specimen of bluish marl from Skye, labelled "Canal, Icolmkill, Skye," bearing on one surface a crowded layer of the delicate *Estheriæ* described above. These are alluded to by Sir R. Murchison as "*Tellinæ* (?)" in his memoir "On the Coal-field of Brora, in Sutherlandshire, and some other Stratified Deposits in the North of Scotland," in the 'Transact. Geol. Soc.,' 2nd

series, vol. ii, part 2, p. 311; where he says, referring to some strata in Skye, "That the strata of this series [with *Belemnites abbreviatus*, Mill., and *Ammonites Murchisoniæ*, Sow., &c., Middle and Lower Oolite] were originally continuous from the high cliffs between Portree and Holme to the low coast on the opposite side of the island, as stated by Dr. MacCulloch, I can confirm, having found several fossils in blue shale [calcareous], through which a deep canal has recently [1826] been cut by Lord Macdonald, to drain the Lake of Mugsted. Among these shales are the *Ammonites Koenigi*, *Ostrææ* in masses, many *Belemnites*, flattened *Tellinæ* (?), &c."

Estheria Murchisoniæ is dedicated to Lady Murchison, the accomplished wife of the discoverer of this interesting fossil. It probably belongs to some freshwater or estuarine deposit of the Middle Oolite (Oxfordian).

11. Estheria concentrica, *Bean*, sp. Pl. III, figs. 13—17.

Cypris concentrica, *Bean*. Mag. Nat. Hist., 1836, vol. ix, p. 376, fig. 54.

	Inch.			Inch.	
Height	$\frac{7}{24}$	Proportion 1 : $1\frac{1}{3}$—, by $\frac{1}{2}$+.	Height	$\frac{9}{24}$	Proportion $\frac{3}{4}$: 1.
Length	$\frac{9}{24}$		Length	$\frac{12}{24}$	
Thickness	$\frac{4\frac{1}{3}}{24}$				

Carapace suboviform; truncate and very slightly curved at one end (posterior?), well rounded, and narrower, at the other; nearly straight on the dorsal and ventral margins; umbos large, slightly projecting over the straight hinge-line, nearly at its centre. The dorsal profile of the carapace (fig. 14) is acute-elliptical, somewhat sharper at one end (anterior?) than at the other. The surface is marked with very numerous (60?) closely set ridges or wrinkles and intermediate striæ; the latter are seen, in the interspaces (when these are broad enough), to accompany an obscure reticulation, or linear dotting, parallel with the striæ (fig. 15).

In Loudon's 'Magazine of Natural History', 1836, vol. ix, p. 376, Mr. William Bean gave a "description and figures of *Unio distortus*, Bean, and *Cypris concentrica*, Bean, from the upper sandstone and shale of Scarborough; and *Cypris arcuata*,[1] Bean, from the Coal-formation of Newcastle."

Unio distortus (fig. 53) is first described. The following is the description given of *Cypris concentrica* (fig. 54):—"Shell oval, convex, one end a little broader than the other, strongly wrinkled transversely, and covered with minute concentric striæ; the hinge-line is prominent, and this species has more the appearance of a bivalve shell than any of its congeners. Colour, pale brown. Length, nearly 4 lines. Breadth, 6 lines. The

[1] This is a *Beyrichia*, and is not uncommon in the Coal-measures.

monarch of this tribe. From the same place as the last, where it occurs sparingly in every part of the sandstone and shale, that contains vegetable remains.

"Only these two species of shells have yet been discovered in this interesting spot, and they are certainly of sufficient geological importance to deserve recording. Depressed specimens of *Cypris concentrica* are found also in the lower sandstone and shale at Cloughton and Haiburn Wyke."

The order of succession of the shales and sandstones beneath the Cornbrash on the Yorkshire coast has been given in detail by Dr. T. Wright, F.G.S., in the 'Quart. Journ. Geol. Soc.,' vol. xvi, p. 31, thus:

		Ft.	In.	
1.	Cornbrash.			
2.	Carbonaceous sandstone	40	0	Upper shales and sandstones.
3.	Siliceous rock	4	0	
4.	Grey clays	6	0	
5.	Grey sand-rock	8	0	
6.	Brown sand-rock	2	0	
7.	Whitish and carbonaceous sandstones, with stems of Plants	4	0	
8.	Carbonaceous sandstone, with stems of Plants	9	0	
9.	Sandy shales	10	0	
10.	Grey limestone. Fossiliferous, marine	18	0	
11.	Carbonaceous sandstone, with Plant-remains	6	6	Lower shales and sandstones.
12.	Carbonaceous shale	1	0	
13.	Dark-grey clay	4	0	
14.	Sandstone and clay, carbonaceous	2	0	
15.	Sandy clays. *Unio distortus* and Plant-remains	3	0	
16.	Carbonaceous shale. Plant-remains	1	0	
17.	Carbonaceous shales and sandstones	1	6	
18.	Carbonaceous shale. *Uniones* and Plant-remains	4	0	
18*a*.	Shale and ironstone	2	0	
18*b*.	Sandstone	1	0	
19.	Shale (Gristhorpe Plant-bed). ESTHERIA CONCENTRICA	2	0	
20.	Sandstone	12	0	
21.	Ferruginous sand-rock. *Pholadomya, Cardium, Trigonia*	5	0	
22.	Sandstone	4	0	
23.	Ironstone-rock. *Lima, Serpula*	2	0	
24.	Shale and sandstone. Plant-remains	4	0	
25.	Dark-grey clay. Plant-remains and ESTHERIA CONCENTRICA	10	0	
26.	Oolitic rock (Millepore-bed). Fossiliferous, marine.	10	0 and more.	

Dr. Wright remarks, bed No. 25 (the 26th beneath the Cornbrash of the Yorkshire coast) is "a dark-grey clay, containing the remains of Plants in its upper portion, and

comparatively unfossiliferous in its lower division. This bed is well seen in the coast-section at Haiburn and Stainton Dale cliffs, where it becomes more sandy and passes into the 'block-sandstone' which rests upon the Millepore-bed. Mr. Leckenby collected *Cypris? concentrica*, Bean, from the clays of this bed at Gristhorpe, where it is about ten feet thick."

Mr. Leckenby informs me (January 26th, 1861) that he has collected some three or four specimens of the fossil in question, and that Mr. Bean says that he may have found in all above a dozen examples. They have been found, he observes, in the bed No. 19 of Dr. Wright's list, the rich deposit of fossil ferns at Gristhorpe Bay, also in bed No. 25, both at Gristhorpe and north of Scarborough, and, "in short, wherever plants have been found, the 'Cypris' has been found, although most rarely, associated with them."

The finest specimens collected by Mr. Bean (figs. 13—17) are now in the British Museum; and, excepting some specimens of *E. minuta* from Pendock, are the best-preserved carapaces of fossil *Estheriæ* that I have seen. In size they greatly surpass these Triassic specimens; but they have their equals in that respect, and their superiors as to beauty of outline and ornament, in several of the *Estheriæ* figured and described in this Monograph. Few, however, if any, surpass them in geological interest—existing witnesses, as they are, of the old freshwater conditions of this portion of the European Jurassic area.

12. Estheria elliptica, *Dunker*. Pl. III, figs. 18—29; and Pl. IV, figs. 1—7.

Cyclas subquadrata, *Sowerby*. Fitton's 'Strata below the Chalk,' Trans. Geol. Soc., 2nd series, vol iv, part 2, 1836, p. 177 and p. 345, pl. 21, fig. 8.

Estheria elliptica, *Dunker*. Programm höh. Gewerbschule Cassel, 1843, p. 41; Stud. Götting. Ver. bergmänn. Freunde, vol v, part 2 (1843?), p. 175; Monographie Norddeutsch. Wealdenbildung, 1846, p. 61, pl. 13, fig. 33.

— subquadrata, *Dunker*. Stud. bergm. *l. c.*; Monogr., p. 62.

	English.		Adult German form.	Young German form.	Suborbicular variety.
Height ...	$\frac{1\frac{1}{2}}{12}$ inch	$\frac{1\frac{1}{2}}{12}$ inch	$\frac{4}{12}$ inch	$\frac{1\frac{1}{4}}{12}$ inch	$\frac{2\frac{3}{4}}{12}$
Length ...	$\frac{2}{12}$ "	$\frac{2\frac{1}{2}}{12}$ "	$\frac{6}{12}$ "	$\frac{1\frac{3}{4}}{12}$ "	$\frac{3}{12}$
Proportion	19 to 26, or 1 : $1\frac{1}{2}$—	10 to 16, or 1 : $1\frac{1}{2}$+	23 to 38, or 1 : $1\frac{1}{2}$+	15 to 22, or 1 : $1\frac{1}{2}$—	33 to 36, or 1 : 1 +

Carapace-valves more or less elliptical or oval, sometimes suboblong. The two extremities are nearly equally curved in outline. In our English specimens (var. *subquadrata*, Pl. III, figs. 18—27), which are suboblong, sometimes the one end and sometimes the other appears to have the boldest curve, but the frequently crushed state of the valves makes this an uncertain feature. The well-preserved German specimens

present relatively large, oval, Anodon-like valves (Pl. IV, fig. 1), more acute behind than before; also some small, oblong, probably young valves (figs. 2 and 6); and thirdly, a suborbicular individual (fig. 3), curiously analogous to the subquadrate or suborbicular forms of *E. Manga-liensis* (Pl. II, figs. 20, 23) and *E. striata* (p. 26, fig. 2). The shape of the last reminds us of some American Unios.

Behind, the hinge-line (which in most specimens is equal to more than half the length of the valve) is lost in the curved slope of the postero-dorsal region; in front, it is ended by the umbo, which projects at the antero-dorsal angle above the convexity of the anterior margin, except in the young individuals from Hanover, in which case it is much less distinct (Pl. IV, figs. 2 and 6).

The surface of the valves bears twenty, and often many more, concentric ridges, which are usually much crowded towards the ventral border. The ornament of the interspaces consists of transverse wrinkles or vertical bars, sometimes branched and inosculating. These are coarser in the English variety (Pl. III, figs. 20—29) than in the German specimens (Pl. IV, fig. 7). The concentric ridges are often so closely set that the sculpturing is obsolete (figs. 4 and 5). In some specimens, from near Hastings, the lower edges of the ridges are delicately crenate (Pl. III, figs. 28, 29). Occasionally a granulate ornament accompanies the little vertical bars (fig. 20, from Bulverhithe).

The sculptured interspaces of *E. elliptica* are imitated in two recent *Estheriæ*. *E. donaciformis*, Baird ('Proc. Zool. Soc.,' 1849, p. 89, Annul., pl. 11, fig. 5), from Africa, has the inosculating wrinkles; and *E. similis*, Baird (op. cit., p. 90, pl. 11, fig. 7), from India, has the short, vertical bars, together with an exaggerated crenulation or beading of the concentric edges. These *Estheriæ* also more or less resemble *E. elliptica* in the shape of the carapace.

Of the North German specimens with which I was kindly supplied in 1858 by my friend, Professor Dr. W. Dunker, of Marburg (who also gave to Dr. Mantell the fine specimens now in the British Museum, and figured in Pl. IV, figs. 1—7), we learn, from his 'Monographie der Norddeutschen Wealdenbildung' (4to, Brunswick, 1846), that they occur in the black Cyrena-shale, with *Cypridæ*,[1] of the Obernkirchn and Südhorst districts in Hanover.[2] He describes them as follows:

"*Estheria elliptica*, p. 61 (Dunker, 'Progr.,' p. 41; 'Stud.,' p. 175).—Estheria valvis ellipticis, planiusculis, tenerrimis, membranaceis, concentrice leviter sulcatis et striatis, umbonibus obsoletis." The length is given as from $3\frac{1}{2}'''$ to $5'''$ and more; and in proportion to the height as 100 : 75.

Estheria subquadrata (p. 62) is described as somewhat smaller, less arched on the dorsal and ventral borders, and subquadrangular. This is probably immature (figs. 2 and 6 of our Pl. IV). The English variety, though adult, retains this form.

[1] See further on, Appendix. The *Cypridæ* are calcareous; the shale and the *Estheriæ* are not.

[2] The Wealden area of North Germany is also described in Giebel's 'Gæa Germanica,' p. 251, &c.

Dr. Dunker adds:—"Another very similar, but doubtful, form occurs in the lower calcareous and marly portion of the Wealden, near the Serpulite-beds, on the Süntel."

In the Rev. J. H. Austen's 'Guide to the Geology of the Isle of Purbeck,' 1852, p. 14, one of the Lower Purbeck beds (No. 128) is said to contain *Estheriæ*;[1] but these are impressions of Archæoniscal fragments, as the Rev. O. Fisher first suggested.

Dr. Fitton and Mr. J. de C. Sowerby have noticed the English form of *Estheria elliptica*, under the name of *Cyclas subquadrata* ('Geol. Trans.' 2nd ser., vol. iv. p. 177, and p. 345, pl. 21, fig. 8), as occurring at two localities near Hastings. Dr. Dunker did not observe this when describing his specimens; and he independently gave the name "subquadrata" to one of the forms he met with in Hanover. As the large forms of *E. elliptica* are typical of the species, and as the smaller and subquadrate individuals are either immature or varietal, both names are not required; but the type retains the appellation given by Dunker, and the twice-given name *subquadrata* belongs to the small form found both in Germany (with the type) and in England. In Dr. Fitton's memoir, "On the Strata below the Chalk," *loc. cit.*, pl. 21, fig. 8, we have a sketch of eight specimens of natural size, on a piece of shale, and an enlarged view of an individual, described by Mr. J. de C. Sowerby, at p. 345 of that memoir, as "*Cyclas subquadrata*: transversely oblong, with straight sides; strongly marked with lines of growth; flat (perhaps from pressure). Found at St. Leonard's, Sussex." The locality would more correctly be *Bulverhithe*; for at p. 177 *C. subquadrata* is said to occur in the "Hastings sand, East Cliff, Hastings, in soft, fine, sandy clay, not effervescent; also cliff west of St. Leonard's;" and at the first cliff (Bulverhithe) in this direction they are found in plenty.

The English Wealden *Estheriæ* that I have seen are from that portion of the formation known as the "Hastings Sand," and from two or three horizons in that series.

1. From the neighbourhood of Tunbridge Wells. This specimen, given to me by the late Dr. Mantell, is a hard, grey, fine-grained, sandy, micaceous shale or mud-stone, retaining casts of *Cyrenæ* and small *Paludinæ* on one bed-plane, and *Estheriæ* on another (about half an inch apart). The valves are represented by dark-brown films, mostly crumpled, and by impressions. A trace of the original bar-ornament (Pl. III, fig. 24) can here and there be detected.

The Hastings Sand of the neighbourhood of Tunbridge Wells has been well described by Mr. F. Drew, F.G.S., in the 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 276, &c.; but I cannot indicate the stratum from which Dr. Mantell obtained the specimen under notice.

2. From the East Cliff, near Hastings; collected and communicated by Mr. S. H. Beckles, F.R.S., F.G.S. This is a hard, light-brown, fine-grained, micaceous, sandy shale, with numerous brown, crushed carapaces on a bed-plane, and with *Cypridæ* scattered in the matrix. Mr. Beckles informs me that this specimen was taken from the lower part

[1] The Rev. O. Fisher, F.G.S., informs me that he found these specimens and showed them to Prof. E. Forbes (then at work on the Purbeck beds), who thought they might be *Estheriæ*. It was upon this information that they were noted in his pamphlet by the Rev. Mr. Austen, who has lately shown them to me.

of the cliff, just above the "lowest shale" of Mr. Webster's section, published in the 'Transact. Geol. Soc.,' 2nd ser., vol. ii, p. 34, pl. 5. From this hand-specimen we have figs. 25—29 of Pl. III, some of which show the crenulate ridges and the bar-ornament of the interspaces.

3. From a higher horizon in the East Cliff, Hastings; collected by Professor Morris, F.G.S., and myself. A hardish, yellowish-grey, fine-grained, slightly micaceous shale, imbedding scattered carapace-valves.

4. A grey, indurated, fine-grained, micaceous shale, containing scattered, brown valves, showing their form and sculpture, and numerous fragments also, from the same locality and series as the foregoing; but its exact place not known. Communicated by Mr. Beckles.

The following section of the strata observed in the cliffs immediately east of Hastings,[1] shows the horizons at which *Estheriæ* are believed to occur in the Hastings Sand series.

Section of the East Cliff, Hastings.

	Feet.
Loam and clay, with thin ironstone, containing *Cyrena*	5
Grey and yellow sandstone, with Plant-remains. Bones at the base	25
Hard, blue, calciferous sandstone, used for building	2
Blue shale and ironstone	2
Blue, laminated, calciferous sandstone, softer and coarser than that mentioned above	2
Shales, with ironstone nodules. *Endogenites, Cyrena*	10
Soft sandstone, mostly white, ferruginous in parts, sometimes laminated. Plant-remains, vertical tubes (root-marks ?), *Cyrena, Paludina* ...about	100
Marly beds (ESTHERIA) and hone-stone, about 5 ft. [Morris and Jones.]	30
Shale, including ironstone, with *Cypridea Valdensis*, Fish-scales, and Insect-remains, 1ft. 3 in. [Binfield]	
Four beds of hard sandstone, with iron-ore and shaly partings	
Clays, blue, ochreous, lignitiferous, &c., with sandstone bands. [ESTHERIA and Insect-remains in the brown, sandy shale at the top. Binfield.]	20
Shales [Plant-remains, Insect-remains, and *Paludinæ* in the middle brown band. Binfield]	7
Bluish-grey sandstone and clay	20
Ironstone (lignitiferous), shale (ESTHERIA ?), and sandstone—seen on the shore. About	10 (?)

Further to the east, the last-mentioned group of beds (*m m* of Mr. Webster's section,

[1] The upper portion of this section is chiefly based on data supplied by Mr. Clement Sharp to Mr. J. Pitter in 1855, and obligingly communicated to me in 1860. The lower part has been described by Messrs. Binfield, in the 'Quart. Journ., Geol. Soc.,' 1854, vol. x, p. 175; where, also, references to Webster's and Fitton's sections will be found. Dr. Fitton found *Estheria* in the East Cliff, and at Bulverhithe.

before referred to) forms part of the cliff (about 10 feet); and, according to Mr. Beckles, (' Quart. Journ. Geol. Soc.,' 1856, vol. xii, p. 290) is succeeded by—

	Feet.
Sandstone	4
Slate-coloured, compact clay	7
Light-coloured clay	4
Dark clay. (The lowest bed seen in the Sussex Cliffs.)	

5. Another locality for *E. elliptica*, var. *subquadrata*, is a low cliff, nearly two miles west of St. Leonard's, and three and a half west of the East Cliff, Hastings. It is at the first rising of the cliffs between St. Leonard's and Bexhill. The geological position of the shales forming this low cliff at Bulverhithe, and rich with *Estheriæ*, is not clearly evident at first sight, on account of the valley intervening between Bopeep (St. Leonard's) and Bulverhithe. It is probable that, by means of a fault of considerable downthrow, the upper portion of the Hastings Sand series has been here lost to sight, and that the section at Bulverhithe commences with beds lower in the series than the thick, soft sandstone of the Castle Rock, Hastings, and of the cliffs behind the western end of St. Leonard's. In this case the Estherian Shales at Bulverhithe would be at nearly the same horizon above the clays at the base of the series there, as Mr. Binfield's clays with *Estheria* are with respect to the lower clays of the eastern cliffs. The following is the section of the strata in the cliff at Bulverhithe and the succeeding cliffs to the westward.

Section of the Bulverhithe and Bexhill Cliffs, Sussex.

	Feet.
Yellowish-brown and grey shales, with a thin, grey ironstone	7
Bluish-grey and brown shales, with sandy seams. A few *Estheriæ*	$2\frac{1}{2}$
Brown and blue shales, and sandy seams. *Estheriæ* abundant, especially in the lowest bed	$2\frac{1}{2}$
Sandstone, and three shaly seams	20
Hard sandrock, with concretions and irony seams	4
Finely laminated grey sandstone and shale, with ferruginous concretions	3
Ferruginous sandrock	4
Soft, clayey, ferruginous, concretionary sandrock, blue-hearted	4
Ferruginous sandstone, with a seam of grey shale ... About	10
Sandstone. (A well-marked stratum)	4
Dark-grey, sandy, lignitiferous shale, with a ferruginous band	3
Grey shale	3
Ferruginous sandstone	3
Olive-brown and bluish shales	6
Sandrock and ferruginous band	4
Red and mottled clay, concretionary, and containing irregular bands of stone. More than	20 feet seen.

A considerable part of the above section is seen in Galley Hill, near Bexhill (fig. 10). West of Galley Hill, between it and the road leading from Bexhill to the beach, is a fault (accompanied with minor slips), which brings the red clays down again to the beach; and westward of this the shales and sandstones that overlie the clays form the surface-ground, undulating along the low cliffs from Bexhill to beyond Couden, and broken by some slight faults, until they reach Pevensey Sluice, where they sink beneath the marshes, and doubtless are succeeded, in the interval between that spot and Pevensey Castle by sandstones and other beds equivalent to the higher part of the series seen at St. Leonard's and Hastings.[1] The Estheria-shales are, therefore, not seen in this direction. They have not been detected (that I know of) in the strata near St. Leonard's, but they may probably be found in the railway-cutting behind Bopeep. The arrangement of the strata between St. Leonard's and the East Cliff does not admit of these shales coming into view; as the upper beds of the Hastings Sand series lie near to the sea-level, until they come up again at White Rock and under the coastguard-station. Rising still more in the Castle Hill and in the East Cliff, the lower strata are recognised, and among them beds with *Estheriæ* occur at two, if not three, levels along the cliffs, in the space of a mile or so. The horizon at which I have myself (in company with Prof. Morris) seen them is in a bed lying upon the hone-stone in the East Cliff, and about eighty feet above the bottom clays. About thirty feet lower down Messrs.

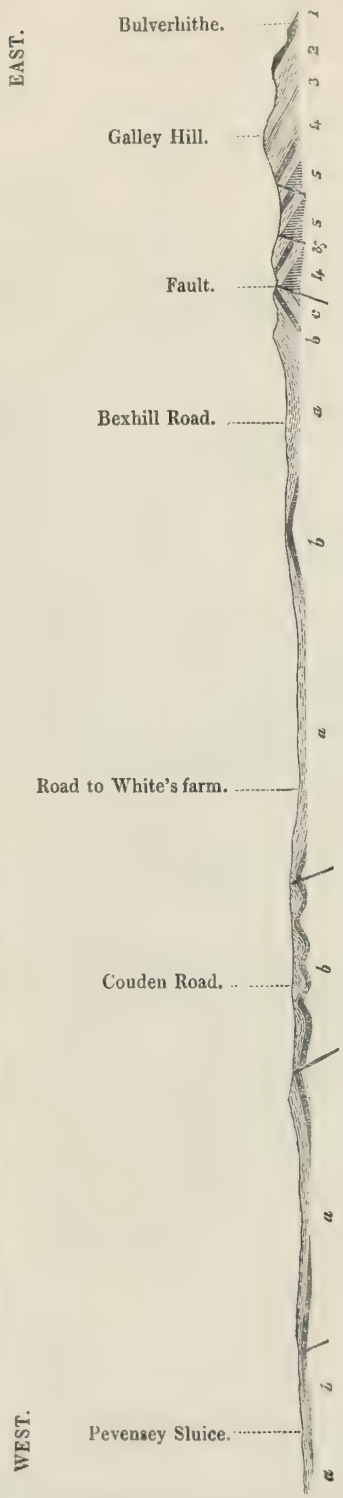


FIG. 10.—*Section of the Wealden Beds, as seen on the Coast to the west of St. Leonard's, Sussex. Length, 5 miles.*

a. Sandy beds, probably equivalent to beds lying above No. 4.
b. Shales, bearing reptilian footprints at various places along the shore from Bexhill to Pevensey Sluice, and probably equivalent to the shales No. 4.
c. Sandy beds, probably equivalent to those underlying shales No. 4.

1. Estheria-shale at Bulverhithe (first cliff west of St. Leonard's).
2. Sandstone.
3. Shaly beds in the sandstone.
4. Grey shales and sandstone.
5. Red and mottled clay, with irregular beds of stone.

[1] In collecting the data for the foregoing section, at various times, I have had the assistance of my friends, Prof. Morris, F.G.S., and Mr. A. Tylor, F.G.S.

Binfield noticed them, and I believe that Mr. Beckles has found them at another horizon, still lower by about forty feet. (See page 106.) As the equivalents of these lower shaly beds containing *Estheriæ* appear to me to occur along the Bexhill and Couden Cliffs (at a lower geological horizon than the Estherian shales of Bulverhithe, by about fifty feet), search might well be made there for these interesting little fossils. These are the shales which have afforded the Reptilian footprints to Mr. Beckles' researches.[1]

The specimens of Estherian shale (No. 5) under notice were collected by Prof. J. Morris, F.G.S., and myself at Bulverhithe[2] from the first set of strata met with in the first cliff westward of Bopeep (St. Leonard's). They consist of a soft, thinly laminated, bluish, fine-grained, micaceous shale, weathering grey and brownish grey. The valves are very numerous, but not in a good state of preservation, only very thin, brown films remaining, but these sometimes show both form and ornament very satisfactorily, as seen in Pl. III, figs. 18—21.

Estheria elliptica, Var. subquadrata. Pl. III, figs. 18—29.

By this title, based on the trivial name used independently by Sowerby and Dunker, I designate our English form of *E. elliptica*, as at present known to me, and as described above (p. 103); because, although agreeing with the Hanoverian type of the species in general form, habit, and ornamentation, yet our specimens from Sussex uniformily differ in having smaller valves and a coarser bar-ornament. They may have possessed these varietal differences as inhabitants of deltaic or lacustrine waters different from, though coeval with, those of the German area.

The English Wealden *Estheria* (like that of Linksfield, p. 77) has not unfrequently passed for *Cyclas*, and occasionally in collections it has been labelled "Cyclas membranacea, Sow."; and this last-named shell has been quoted as an *Estheria*.[3] There is no doubt, however, that *Cyclas subquadrata*, Sow., in Fitton's "Strata below the Chalk," 'Geol. Trans.,' 2nd series, vol. iv, p. 177 and p. 345, pl. 21, fig. 8, is the *Estheria* under notice.

13. Estheria Forbesii, Spec. Nov. Pl. IV, figs. 8—11.

Height of valve	$\frac{3\frac{1}{3}}{12}$ inch .... more than	$\frac{5}{12}$ inch	$\frac{2\frac{1}{2}}{24}$ inch.
Length.........	$\frac{5}{12}$,, ... less than	$\frac{6}{24}$,, ...	$\frac{3\frac{1}{3}}{24}$,,
Proportion ...	10 to 15, or $1 : 1\frac{1}{2}$	31 to 35, or $1 : 1+$	15 to 20, or $1 : 1\frac{1}{3}$.

Carapace-valves ovato-oblong in the adult (fig. 8), suborbicular in the young state

[1] 'Quart. Journ. Geol. Soc.,' vol. x, p. 456, where further references are given. See also the paper by Mr. A. Tylor on the same subject, *ibid.*, vol. xviii, p. 250, where a general section of the Sussex cliffs indicates the relative positions of these various shales.

[2] This is doubtless the "cliff west of St. Leonard's" where Dr. Fitton found *Estheria*.

[3] Jukes's 'Student's Manual of Geology,' 2nd edit., p. 605.

(figs. 9 and 10). Valve well rounded in front and behind, but somewhat obliquely; the antero-ventral and postero-dorsal margins sloping parallel to each other, and giving a somewhat rhomboidal outline to the full-grown shell. The ventral margin gently rounded in the adult, fully rounded and almost semicircular in the young state. The dorsal margin straight along the hinge-line, which occupies the middle of the border for a distance equal to more than half the length of the valve, and sloping off rapidly before and behind. Umbo distinct, terminating the hinge-line in front, and situated one fifth of the length of the valve from the anterior extremity. Ridges distinct, wide apart, about twenty-two in the adult; the interspaces ornamented with a delicate, irregularly hexagonal reticulation (fig. 11), with about seventeen meshes from ridge to ridge, and very similar to the ornamentation of *E. minuta*, var. *Brodieana* (Pl. II, fig. 15).

The species under notice is new; the specimens were collected in large quantities by Mr. David Forbes, F.R.S., F.G.S., three or four years since, at a place called Cacheuta, about 3500 or 4000 feet above the sea, on the eastern slope of the Andes, south of Mendoza; and I dedicate the species to this adventurons geological explorer of Chili, Bolivia, and Peru, some of the results of whose researches in these regions are published in the 'Quart. Journ. Geol. Soc.,' vol. xvii.

Mr. D. Forbes informed me that he discovered these fossils "in soft beds, together with abundant impressions of ferns, rushes, and reeds." He adds: "I found no other fossils. The beds are tilted, and in some places much altered by volcanic rocks, and appear to correspond with the beds in Darwin's section of Uspalata Pass,[1] in which he found a fossil forest."

E. Forbesii occurs in a pinkish-grey, finely laminated shale, indurated, and not breaking evenly along the lines of bedding. The carapace-valves are abundantly strewed throughout the shale, but do not lie very closely together; they are fawn-coloured, sometimes closed and filled with the matrix; generally separate, but not unfrequently in pairs, with the dorsal edges approximated, and sometimes retaining a considerable amount of convexity. Valves of young individuals are not uncommon among the others. Fragments of Ferns or Cycads and other obscure Plant-remains are scattered here and there.

The preponderance of the immature and somewhat suborbicular valves of this wide-ridged species on some specimens of the shale reminds one of the Pennsylvanian *Estheriæ*, when these have not their ridges crowded up into striæ. Moreover, the immature form of the South American species (Pl. IV, fig. 9) is much like a youngish individual of the North American *E. ovata* (Pl. II, fig. 26). They differ, however, in the dorsal angles; and the adults differ still more in outline, the narrower and exceptional form of *E. ovata* being scarcely worthy of being taken into account, as its shape may be due to oblique pressure or imperfect exposure of the margins of the valve. The pattern of ornament of *E. Forbesii* (Pl. IV, fig. 11) is not widely dissimilar from the reticulate

[1] 'Geology of South America,' p. 202.

sculpture sometimes seen in *E. ovata* (Pl. II, fig. 33); but the bar-ornament of the latter is wanting.

E. Forbesii, though considerably larger, has much the same outline as some individuals of *E. minuta* (Pl. I, fig. 29); it has the same distinctness in its ridge-growth, and the same kind of ornament (the pattern being relatively smaller than that of the typical form, and scarcely larger than that of the Rhætic variety). Still, its much larger size, and its suborbicular form in the immature state, together with its occurrence in the other hemisphere, are sufficient to keep it specifically apart. The fact, too, that the reticulate ornament, but slightly modified, occurs on several modern as well as ancient species, must make us careful in applying it as a specific character either of alliance or distinction.

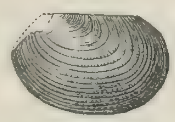
The geological position of the Estherian shale under notice is doubtful, and the *Estheria* itself affords no certain clue to its determination. The nearest ally (though sufficiently distinct) is *E. ovata* of the North American continent. Through possibly of Lower Mesozoic age, still the shale may belong to the Upper Mesozoic, or even to the Tertiary, period, so isolated is the place of deposit, and so manifold are the alliances of the animal, as far as the characters of the carapace are concerned.

14. Estheria Middendorfii, Spec. Nov. Pl. IV, figs. 12—22.

Height of valve......... $\frac{3}{6}$ inch } Proportion 3 to 5, or 1 : $1\frac{1}{2}$ +
Length .... $\frac{5}{6}$,, }

Carapace-valves thin, suboblong, straight on the dorsal margin, nearly the whole of which is occupied by the hinge-line; umbo forward, not preserved in the many specimens seen; ends well rounded, and nearly equal; ventral margin gently and nearly symmetrically curved. Ridges distinct, about twenty-four, sometimes more numerous, and crowded towards the ventral edge; interspaces bearing an open, irregular reticulation (fig. 16), often passing into thin, transverse, somewhat irregular riblets (fig. 15); the irregularly hexagonal areas of the reticulation, when highly magnified, are seen to be delicately punctured (fig. 19).

Fig. 11.



Estheria Middendorfii, from Siberia. Natural size.

This fine *Estheria*, one of the largest known, occurs fossil in Siberia; it has been noticed by Dr. A. Th. von Middendorf (see further on). Most of the specimens that I have seen were brought to England by Mr. C. E. Austin, F.G.S., and are doubtless similar in every respect to those alluded to by Von Middendorf. They consist of a bluish-grey, finely laminated shale, slightly micaceous, indurated, fissile, and easily broken into irregularly shaped pieces. Some of the shale has the surface-planes of all the laminæ

thickly strewed with flattened carapaces of *Estheriæ*, accompanied with an occasional small Fish,[1] represented by a dark stain and the skeleton. In other specimens the Fishes are abundant, and the Crustaceans rare. Both valves of the carapace are in most cases present, and but little displaced; and sometimes what appear to have been the *ova* of the *Estheria* have left traces, in the form of small, globular grains. No other remnants of the organs of the animal have been discerned, although the thinness of the carapace, as delicate as the wing of an insect, would allow of such being seen. The valves have a light-brown colour, and are for the most part glossy along fine lines, corresponding chiefly to the concentric ridges, which present more solid, chitonous carapace-matter, whilst the finely reticulate interspaces do not reflect the light so readily. Frequently the valves are more or less crumpled with small, transverse wrinkles.

We have no finished sketch of *E. Middendorfii* on Pl. IV, on which the size of the valve is shown by fig. 12; the outline, magnified six times, for comparison with all the other Estherian valves figured on the same scale, is shown by fig. 13. The reticulated surface is shown on the lower part of fig. 16; the interior cast (on the shale) of that network is seen in the upper part of the same; the ova also are seen here, and more highly magnified in figs. 20, 21, 22. Fig. 17 is the natural cast of a reticulated interspace, somewhat resembling that in the lower part of fig. 16; fig. 14 is a similar cast of an interspace, having transverse riblets; and fig. 15 represents the ribbed interspace, restored by Mr. G. West, with setaceous ridges, that have left evidence of either setæ or rugæ in the specimen shown in fig. 14. Another natural cast of a reticulated interspace is given in fig. 18, but the clay has here replaced the raised network.

The first notice of *E. Middendorfii* is in Dr. A. Th. von Middendorf's 'Sibirische Reise,' Band i, Theil 1 ("Einleitung; Klimatologie; Geognosie"), 'Fossile Fische,' Bearbeitet von Joannes Müller,[2] p. 259, &c. Dr. Müller here describes the little fossil Fish, *Lycoptera Middendorfii* (which Sir P. Egerton informs me is probably an *Aspius*), together with a bivalved Crustacean, *Limnadia* (my *E. Middendorfii*). A larva of an Insect, probably neuropterous (neither *Ephemera* nor *Æschna*, but supposed to be possibly allied to both), and an obscure Paludina-like shell, were the only other fossils found in the Estherian shale. The Fish (figs. 1—5), the Crustacean (fig. 6), and the Larva (fig. 7), are carefully figured in pl. 11 of the work alluded to. At pp. 263 and 264 the shale and its locality are thus described by Von Middendorf:

"About 140 to 150 versts south of Nertschinsk, and some 70 versts from the nearest point of the Chinese frontier, a river named Býrka falls into the right side of the Turgá, at 40 versts above the confluence of the Turgá with the Onón, into which the Turgá also empties itself from the right. From the above-mentioned mouth of the Býrka downwards, a shaly clay forms the right bank of the Turgá, which has cut for itself a deep and pre-

[1] *Aspius* or some closely allied genus; according to Sir P. Egerton, Bart., F.R.S., &c.

[2] See also the 'Quart. Journ. Geol. Soc.,' vol. vi, part 2, "Miscell.," p. 45.

cipitous bed in the shale. At the depth of about a fathom from the surface the fossils are found in this shale. The Fish and Shells[1] occur throughout, and near one another, and not at all in separate beds; yet on the bank-cliff itself Shells occurred, but further inland Fish were laid bare by digging. The Crustaceans (*Limnadia*) are found, however, in another place of the said bank, evidently an ancient puddle of standing water. The shale s as yet not otherwise penetrated, but evidently extends to a great depth. The uppermost beds are, as it were, fatty, perhaps from the remains of decomposed Fish. About 40 versts southward from this place begin the wide, endless plains of the Mongolian Steppes. On the right bank of the Onón, at 30 versts upwards from the mouth of the Turgá, Fish-casts are also said to occur; according to the report of the Burats, there the shale is, as it were, pervaded with mica-flakes.[2]

M. E. d'Eichwald, of St. Petersburg, has favoured me with some pieces of this Siberian shale; he speaks of it as coming from near the village Tourtscha, on the banks of the Bibaya stream, which falls into the River Belaya, in the district of Nertschinsk.

Several specimens of this grey shale, containing Fishes and the interesting Entomostracans under notice, were presented to the Museum of the Geological Society in 1858 by Mr. Charles E. Austin, C.E., F.G.S., who collected them, in 1848, near Tourga (lat. about 51° 30′ N., long. 116° E.), from a cliff about 10 or 15 feet high, forming the western bank of the small stream Burká, flowing southward into the River Onón, at a distance of about 200 versts (about 133 miles) south-by-east from Nerchinsk, and between Tourga, Nerchinsk (or Nertschinsk), and Adoon-Zabor.

From information communicated by Mr. Austin I learn that on the bank of the stream, between the rising ground (above 100 feet high, formed chiefly of a gravel of augitic porphyry) and the stream, a shaft was sunk to examine the strata and to get specimens; and this penetrated—1st, some alluvium; 2nd, gravel of trap-rocks, with layers of soft clay and broken indurated shale, 2 feet 6 inches; 3rd, broken indurated shale, 1 foot 6 inches; 4th, white clay, 2 feet; 5th, slabs of the indurated fossiliferous shale in soft clay, 1 foot 6 inches; 6th, ferruginous clay, 1 inch. These beds seemed to dip westwardly at an angle of 25°. About 300 yards to the north of this spot, under a similar gravel, shale-beds, like the former, but unfossiliferous, intercalated with clay, 18 inches thick, and underlaid by 6 inches of rounded trap-detritus, are raised up and broken by a boss of basalt; these continue for some distance northwards in the bank of the stream, and ultimately disappear under a cliff of brown earth or volcanic tuff. On the eastern side of the stream is a plain, with outbursts of augitic porphyry, with asbestose serpentine, basalt, and greenstone, bounded by granitic hills running north and south, and

[1] Middendorf's term "Shells" here is equivalent to "Crustaceans" just below. He wrote this notice of the locality after Müller had recognised the Crustacean character of what he had previously been used to look upon as molluscs. Besides, there were no real shells found except the obscure *Paludina*.

[2] It is to be remarked that almost all the known Estherian marls, shales, or mud-stones, are more or less micaceous, and therefore formed in quiet waters, where currents have ceased.

associated with lava and scoriæ, and granite rich in garnet, yellow topaz, and aqua-marine. Mr. Austin thinks that the shale-beds formed the surface at the time of the last igneous eruption of any magnitude in that part of Siberia, and that it was then disturbed and covered by the volcanic products. He noticed in the shale, besides the Fishes and Crustaceans, one spiral shell (*Limnæa* or *Paludina?*), several impressions of stems and reed-like plants, and a small rhomboidal piece of lignite; but nothing more definite can be at present said of the age of the deposit than that it is probably of Tertiary age, and of freshwater origin.

Mr. W. Davies, of the British Museum, informs me that *Aspius* (such as accompanies *Estheria Middendorfii*, see above, p. 112) was a true freshwater fish, of the Cyprinoid family, and closely related to *Leuciscus*, differing from the latter genus in having a more compressed body, and a more slender skeleton. The species are found in Miocene Tertiaries, as the freshwater limestone of Œningen and the lignites of Menat, &c.

NOTE.—Although the Purbeck specimens hitherto supposed to be Estherian are Archæoniscal (see p. 105), yet there are real Purbeck *Estheriæ;* for Mr. Harry Seeley, F.G.S., of the Woodwardian Museum, Cambridge, informs me to-day that an *Estheria*, "very like the Hastings species, has just been detected in the Lowest Purbeck beds near Swanage."—*December* 17, 1862.

TABLE SHOWING THE DISTRIBUTION OF THE FOSSIL ESTHERIÆ.

[To face page 114.

GEOLOGICAL STAGES.	EUROPE. British Isles.	EUROPE. France and Belgium.	EUROPE. Germany.	EUROPE. Russia and Baltic Provinces.	ASIA. Siberia.	ASIA. India.	NORTH AMERICA.	SOUTH AMERICA.	ESTHERIÆ.
Tertiary	....	....	....	....	Tourga (age doubtful)	....	....	....	*Estheria Middendorfii* (?).
Cretaceous.[1]									
Wealden	Sussex. Purbeck (?)	....	Hanover	....	....	....	....	....	*Estheria elliptica*, and *E. elliptica*, var. *sub-quadrata*.
Jurassic	Oxfordian, Skye; Lower Oolite, Scarborough	....	....	....	....	Kotah, on the Pranhita	....	....	*Estheria Murchisoniæ*, *E. concentrica*, and *E. Kotahensis*.
Rhætic[2]	Linksfield, Elgin; Warwickshire; Gloucestershire; Somersetshire	....	....	....	....	Mangali and Pan-cheet	Pennsylvania, Eastern Virginia, and North Carolina	Cacheuta	*Estheria minuta*, var. *Brodieana*, *E. Mangaliensis* (?), *E. ovata* (?), and *E. Forbesii* (?).
Trias	Leicestershire; Warwickshire; Worcestershire; Somersetshire	Sulzbad	Hanover and Würtemberg	....	....	....	....	....	*Estheria minuta.*
Permian	Rhone Hill, Tyrone	....	Lower Permian, Saxony	Kargala, &c. ...	....	....	....	....	*Estheria Portlockii*, *E. tenella*, and *E. exigua*.
Carboniferous	Upper Coal-measures, Manchester; Coal-measures, Derbyshire and Lanarkshire; Lower Carboniferous, Berwickshire	Permian (?) or Upper Carboniferous (?), Autun; Lower Carboniferous, Belgium	Permian (?) or Upper Carboniferous (?), Murgthal; Lower Carboniferous, Silesia and Bavaria	....	....	....	....	....	*Estheria tenella* and *E. striata* and its varieties.
	[*Leaia*[3] occurs in the Upper Coal-measures of Lancashire, and Lower Carboniferous of Fifeshire]	....	....	....	....	....	[*Leaia* occurs in the Lower Carboniferous of Pennsylvania.]		
Old Red Sandstone	Caithness and Orkney	....	....	Livonia	....	....	....	....	*Estheria membranacea.*

[1] No fossil *Estheria* are as yet referred to this period, excepting those of the Wealden formation (representing some of the freshwater deposits of the period). There is, however, the possibility of either or both of the Siberian and the South American *Estheriæ* described above being of this age.

[2] The adoption of this stage for the *Estheriæ* from India and America is merely provisional; they may be Triassic.

[3] See the Appendix.

APPENDIX.

LEAIA, Gen. Nov.

I HAVE proposed the above name as a generic denomination for certain peculiar, quadrate, bivalved carapaces, occurring in the Coal-measures of Britain and the Lower Carboniferous red sandstone of Pennsylvania. I know nothing of their nature except that they are small, thin, horny, brown, stiffly quadrate, symmetrical bodies, unlike Molluscan shells, but possibly Crustacean and Phyllopodous.

I have some specimens from the Upper Coal-measures of Ardwick, near Manchester (collected by Prof. Williamson, F.R.S., several years since); and some from the Lower Coal-measures of Fifeshire, collected by Mr. Salter, F.G.S., of the Geological Survey. Dr. Isaac Lea described and figured, a few years ago, a similar fossil from the red sandstone of Pennsylvania, and named it *Cypricardia Leidyi*. All these three are very much alike; but, on account of the obscurity of their relationship, and the distant places, geological and topographical, of their occurrence, and making the most of their slight differences of contour, I propose to keep them nominally distinct as *Leaia Leidyi* (Pl. V, figs. 11, 12), *L. Leidyi*, var. *Williamsoniana* (Pl. I, figs. 19, 20), and *L. Leidyi*, var. *Salteriana* (Pl. I, fig. 21). Dr. I. Lea, of Philadelphia, being the first to notice and figure a specimen of this proposed genus, I have distinguished it by a name commemorative of that well-known conchologist.

The carapace-valves are oblong; truncate behind, with a slight curvature of outline; boldly rounded in front; either straight or somewhat curved on the ventral border; straight on the dorsal edge; a slight umbo takes the place of the antero-dorsal angle, from whence two conspicuous ridges (hollow within) pass along the surface of the valve; one directly across the valve to the antero-ventral angle; the other, and longer one, passes diagonally to the postero-ventral angle; these ridges divide the convexity of the valves into three, unequal, triangular, smooth, sloping areas; the anterior space is the smallest and nearly semicircular; the middle one has its apex at the umbo and its base along the

ventral margin; and the posterior space is based on the hinder margin, and reaches along the dorsal region to the umbo. The surface of the valve is marked with 10-13 (?) delicate ridges (hollow within), concentric, beginning at the umbo, conformable to the outline of the valve, and sharply bent at the divergent ridges; they are curved and closely set on the anterior area; more open, horizontal, and straight, or nearly so, on the middle area; and vertically straight or slightly curved, and wider apart, on the posterior part of the valve.

These symmetrical markings of concentric angular lines and transverse divergent ridges give this fossil, at first sight, a striking likeness to some Fish-scales, when the two valves lie open, in contact by their dorsal edges (as in Pl. I, fig. 19), and produce a bilaterally symmetrical, subquadrate, concentrically lined figure, with triangular sloping areas.

Dr. Lea points out some *Cypricardiæ* and other shells of palæozoic age to which this little fossil has some resemblance in shape; and some *Orthonotæ* have a general resemblance to it; but some of the small *Astartes* of the Chalk and Oolite, such as the *A. Roemeri*, Müller's Petref. Aachen. Kreideform., Pl. 6, fig. 12, and *A. interlineata*, Morris and Lycett, Mollusca of the Great Ooolite (Palæontogr. Soc. Monograph), Pl. 9, figs. 14, 15, have even a greater resemblance in size and shape, without being at all allied to the form before us.

The horny tissue of *Leaia*,—its long dorsal edge, destitute of hinge,—its stiff and simple style of ornament,—and its two diagonal, raised, hollow ridges or folds, remove it from the *Mollusca*. It has been suggested (by Phillips and Williamson) that these fossils may be *Trigonellites* (of *Goniatites*?); but there is little or nothing to support the hypothesis.

Leaia Leidyi, Lea, sp. Pl. V, figs. 11, 12.

Cypricardia Leidyi, *Lea*. Proceed. Acad. Nat. Sc. Philadelphia, 1855, vii, p. 341. pl. 4.

Height of valve, nearly $\frac{3}{24}$ inch } Proportion 7 to 12, or 1 : $1\frac{3}{4}$ —
Length ,, nearly $\frac{5}{24}$,, }

In the 'Proceedings Acad. Nat. Science of Philadelphia,' May, 1855, vol. vii, p. 341, Dr. I. Lea has described a small fossil found by Dr. Leidy in a red sandstone at Tumbling Run Dam, about a mile south-east of Pottsville in Pennsylvania. The specimen consists of the impression of the outside of the two valves. It is figured carefully, of natural size, and enlarged, in plate 4 (op. cit.[1]), and is named *Cypricardia Leidyi*, by Dr. Lea, who thus describes it:

"Shell oblong, round before and truncate behind, very inequilateral, striate; dorsal and basal margins parallel; umbonal slope shortly carinate; anterior slope with an

[1] By inadvertence, the enlarged view is stated to be magnified 10 instead of 5 times.

elevated line from the back to the basal margin; striæ about twelve, very regular, and nearly equidistant (bent at an angle of 90° at the umbonal slope). Length, $\frac{2}{20}$ths, breadth, nearly $\frac{4}{20}$ths of an inch." "The shell is accompanied on the specimen with some obscure impressed linear marks of a plant."

The figures are reproduced here (Pl. V, figs. 11, 12). The sandstone is referred to the formation called No. XI by Prof. H. D. Rogers in the State Geological Survey of Pennsylvania, and referred by him to the base of the Carboniferous system, but regarded by some geologists as the uppermost part of the Devonian or Old Red Sandstone. In this formation of sandstone (which, with its associated shales, is 3000 feet thick), Foot-tracks of Reptiles, Rain-prints, Wave-marks, and Trails of Annelids or Molluscs are not uncommon[1] at two or more horizons.

LEAIA LEIDYI, var. WILLIAMSONIANA. Pl. I, figs. 19, 20.

BIVALVULAR SHELL?, *W. C. Williamson.* Philos. Mag., new series, 1836, ix, p. 351.
APTYCHUS?, *J. Phillips.* Silur. Syst., 1839, p. 89.

	Inch.			Inch.	
Height of valve ...	$\frac{1}{16}$	Proportion 1 to 2.	Height	$\frac{5}{96}$	Proportion 5 to 9, or 1 : 2—
Length	$\frac{1}{8}$		Length	$\frac{9}{96}$	

This is very like *Leaia Leidyi;* but, as it is much smaller, and appears to be still neater in form, and to have a few more striæ, and as it comes from the much higher horizon of the Uppermost Coal-measures, and in England, I propose to treat of it separately, as a variety under the above name, which will associate it with its well-known discoverer, Prof. Dr. W. C. Williamson, F.R.S., of Manchester.

The specimens lie dispersed in a soft grey shale, in considerable numbers, and are not disposed on the planes of bedding. They are from the Uppermost Coal-measures of Lancashire (Ardwick, near Manchester), and were confided to me for examination, in 1856, by Prof. Williamson, who believed them to belong to some nondescript Entomostracan, if they should not prove to be *Trigonellites.* He found them many years ago, and referred to them in a paper (on the Limestones found in the vicinity of Manchester) published in 1836 in the 'Philos. Magaz.,' new ser., vol. ix., from which the following extract has been taken.

"In the blue clay immediately above the 'black bass' are a series of remains, in attempting to decide upon the nature of which I find myself completely puzzled. They are very thin bodies of a brown colour, nearly square in their form, two of the corners

[1] See 'Boston Soc. Nat. Hist. Proceed.,' vol. v. p. 182, and Lyell's 'Manual of Geology,' 5th edit., p. 379, &c.

being angular, and the opposite one rounded. I have some nearly a quarter of an inch across. At first I imagined that these were scales of fish, but now think they must be some bivalvular shell. Their surface is marked with strong concentric ridges; and passing from the hinge (?) to the opposite corners are two diverging elevated lines. I cannot detect any traces of teeth; but have found several specimens in which the two valves (?) were connected at the hinge, and the four ridges commencing from one common point in the centre, and diverging two each way; these I pointed out to Prof. Phillips, who will, perhaps, be able to lay before the public some more decided opinion as to their nature[1]" (p. 351).

At page 245 of the same paper, Prof. Williamson gave a section of the strata at Ardwick, which will serve to illustrate the exact position in which these curious little fossils were found. The section[2] is as follows:—the fossils mentioned in the paper as peculiar to the beds being inserted in their places.

	Feet.	Inches.
Red clays with sandstone (*Unio Phillipsii*[3] in one thin seam), thickness not known.		
Limestone. "Four-feet Mine." (*Megalichthys Hibberti* in the roof. *Microconchus.*)	4	0
Red and blue clay. "Clunch."	6	0
Coarse micaceous grit	6	0
Clunch	6	0
"Roof-stone;" a shaly sandstone	0	3
Limestone. "Yard Mine." (*Microconchus.*)	3	0
Clunch	5	0
Limestone (fragmentary shells in the upper portion: *Unio* ?)	2	0
Clunch and shaly clay	17	0
Limestone	1	0
Red shale. (*Asterophyllites, Calamites decoratus, C. nodosus, Lepidodendron Sternbergii, Stigmaria ficoides, Neuropteris cordata, Cyclopteris, Pecopteris*)	15	0
Limestone	1	6
Coloured clays	45	0
Blue clay. (*Entomostraca* [*Leaia*], *Unio Phillipsii, Sphenophyllum, Pecopteris, Equisetum.*)	1	0
"Black bass:" pyritous shale. (*Unio Phillipsii, Cypridæ*, Fish-remains.)	1	0
Coal. (*Stigmaria ficoides.*)	0	6

[1] Professor Phillips referred to these little fossils in the 'Silurian System,' p. 89 (1839) and suggested that they may be *Aptychi* (*Trigonellites*).

[2] The place of these strata in the general section of the Manchester district is shown in Mr. Binney's paper, 'Trans. Manchester Geol. Soc.,' vol. i, p. 50, pl. 1, fig. 1.

[3] Prof. Phillips terms this shell *U. linguiformis* ('Sil. Syst.,' p. 88); Mr. Binney thinks it may be a *Modiola* ('Manchester Lit. Phil. Soc. Mem.,' vol. xii, p. 221); and Mr. Salter regards it as an *Anthracomya*.

	Feet.	Inches.
Blue clay, sometimes red	5	0
Limestone. Main seam or "Three-yards Mine." (Fish-remains. *Microconchus.*)	9	0
Coloured shaly clays... about	60	0
Coal	1	3
Coloured clays.[1] Thickness not known.		

Leaia Leidyi, var. Salteriana. Pl. I, fig. 21.

Height of valve, more than ... $\frac{1}{24}$ inch } Proportion 7 : 17, or 1 : $2\frac{1}{2}$ —
Length „ less than ... $\frac{3}{24}$ „ }

Some specimens of *Leaia,* resembling both *L. Leidyi* and *L. Leidyi,* var. *Williamsoniana,* in general appearance, but relatively shorter, broader, more strongly ridged, more quadrate, and somewhat more rounded on the ventral and posterior borders, have been placed in my hands by Mr. J. W. Salter, F.G.S., of the Geological Survey of Great Britain. They are from the Lower Carboniferous rocks of Fifeshire, Scotland; and, on account of their differing (though slightly) from the other two forms, and on account of their distant locality and different geological horizon, I shall regard them as belonging to a distinct variety, and give it Mr. Salter's name, to whom I am indebted for the knowledge both of these and very many other palæozoic *Entomostraca.*

These specimens of the variety *Salteriana* are somewhat numerous in a fine-grained, hard, light-brown, clay-iron-stone, from Cottage Row, Crail, Fife; and are dispersed through the stone; about twenty-two are to be seen on five square inches. They are associated, I am informed by Mr. Salter, with *Lepidodendron* and *Lepidostrobus;* and the stratum in which they occur is intercalated between beds full of Brachiopods, together with *Myalina* and *Anthracosia.* Mr. Salter says that similar beds occur in the district, containing *Amblypterus* and *Rhizodus,* with *Cythere* (or *Cytheropsis*) *Scotoburdigalensis.* For an account of the section of the Carboniferous strata of the Fifeshire coast, see the Rev. T. Brown's Papers in the 'Quart. Journ. Geol. Soc.,' 1859, vol. xv, p. 59, and 'Transact. R. Soc. Edinb.,' 1861, xxii, p. 385.

Habitat of Leaia.—The *Anthracomyæ* associated with *Leaia Leidyi,* var. *Williamsoniana,* are probably evidences of at least a brackish condition of the water in which this Crustacean existed.

[1] In the section of the strata at Manchester, given in the 'Silurian System' (1839), p. 87, instead of "clays" at the base, we have "grit or great red rock, with micaceous marls and *Unionies,* 81 feet," and a long list of still lower strata. This section, based on that of Prof. Williamson, and corrected by Prof. J. Phillips, has some discrepancies with the older one, and its plan of classification differs from that adopted by Messrs. Williamson and Binney. All the limestones, however, I believe, are now regarded as belonging to the Carboniferous system; and Prof. Williamson's original section very well indicates the exact place of the *Entomostraca* under notice. Prof. Phillips's account of the fossils from the sections at Ardwick ('Sil. Syst.,' p. 88, 89) necessarily deserves attention.

Notes on the Beyrichiæ and Cypridæ associated with the Fossil Estheriæ.

Occurring with *Estheriæ,* in deposits of different ages, both Palæozoic and Mesozoic, are several small Bivalved Entomostracans, belonging, for the most part, to the *Lophyropoda;* Tribe, *Cyproidea;* Family, *Cypridæ.*[1] A few other *Entomostraca* are associated with some of the Palæozoic *Estheriæ;* and these belong probably to the *Phyllopoda;* Tribe, *Limnadioidea;* Family, *Leperditidæ.*[2]

As it is highly desirable to get as much information as possible respecting the habitats of fossil *Estheriæ,* I determined not to neglect the associated Entomostracan remains; and have, therefore, figured them in Pl. V, and will proceed to describe them: but, with our present knowledge of them and their alliances, they throw but little additional light on the subject. In fact, it is difficult to assign most of them to their sub-families and genera, so similar are the carapaces of some generically distinct *Cypridæ.*

1. Beyrichia subarcuata, spec. nov. Pl. V, figs. 16, 17.

Length, $\frac{1}{22}$ inch. Height, $\frac{1}{45}$ inch.

Carapace-valves elongate-reniform, the length nearly double the height (or breadth); indented at the middle of the dorsal border by a short, transverse notch, reaching about one fourth across the valve, and by another still slighter notch at rather less than half-way between the larger notch and the anterior (?) end of the valve. The surface is delicately reticular, with minute hexagonal pits (fig. 17).

This *Beyrichia* feebly represents the well-lobed Silurian forms of this genus: it is very closely allied to *B. arcuata,* Bean, sp. ('Mag. Nat. Hist.' 1836, vol. ix, p. 377, fig. 55). Indeed it may ultimately prove to be a variety of this species, which is very common in the Coal-measures. *B. subarcuata* occurs with *Estheria tenella* in the Upper Coal-measures at Astley, Lancashire (see page 32); and, if this species had the same habits as the older *Beyrichiæ,* it speaks of marine conditions; at all events we may regard it as at least having a brackish habitat.

[1] See the Synopsis of the *Crustacea,* at p. 10.

[2] This is the grouping which I have proposed for *Beyrichia* and its allies ('Annals Nat. Hist.,' Feb., 1856, p. 99), the carapace alone being considered.

2. Beyrichia Pyrrhæ, *Eichwald*, sp. Pl. V, figs. 18, 19.

Cypris Pyrrhæ, *Eichwald*. (The name only is given in Jazykov's Table of the Formations of the Government of Simbirsk, published by the Petersburg. Mineral. Gesellschaft, 1844, according to Von Keyserling.)

Cytherina Pyrrhæ,[1] *Eichwald*. Geogn. Russl.,[2] 1846, p. 466. Bullet. Soc. Imp. Nat. Moscou, année 1857, vol. xxx, 2nd part, 1857, p. 307.

Bairdia Pyrrhæ, *Eichwald*. Lethæa Rossica, 7th part, 1860, p. 1344, pl. 52, fig. 3 *a*, *b*.

Length of the figured specimen, $\frac{1}{28}$ inch.[3] Height, $\frac{1}{45}$ inch.

Carapace-valves oblong-ovate; extremities nearly equal, the posterior being rather larger than the other; upper margin straight, curved symmetrically at the ends; dorsal region faintly impressed by two short, shallow, transverse indentations, which obscurely divide that part of the valve into three nearly equal parts. The anterior sulcus is the more distinct of the two. A slight, neat, flattened border follows the curved margin of the valve. The surface is beautifully reticulated with minute hexagonal pits (fig. 19).

M. d'Eichwald correctly describes this little fossil as follows, excepting that he omits the ornamentation and the rim, and regards the faint dorsal elevation as due to the internal attachment of the muscle :—"Testa exigua, tenuissima, plana, ovato-dilatata, uno latere latiore altero, utroque rotundato, tuberculo sive eminentia musculari prope marginem dorsalem obvia, foveolam utrinque præ se ferente, oculo non conspicuo." He remarks that the anterior sulcus is more constant than the other, and that some individuals have a more rounded outline than others, and do not show the dorsal protuberance. In the figure given in the 'Lethæa Rossica' the dorsal notches are more distinct than they are in our specimen.

This little Entomostracan has no family-relationship to the *Cypridæ*, and least of all to the sub-genus *Bairdia* in particular. Its general features and its dorsal notches show it to be a *Beyrichia*, though with feeble characters of carapace. Indeed, we may have ultimately, for convenience of grouping, to separate the simpler forms from those with many-lobed carapaces, however gradual may be the stages of difference. Further, the species before us presents an interesting passage-form between the simple *Beyrichiæ* and the non-sulcated carapaces known as *Cytheropses*.[4] The amount of sulcation in *B. Pyrrhæ*

[1] *Cythere Pyrrhæ* (?), Keyserling, in Schrenk's 'Reise,' &c., 1854, p. 112, pl. 4, fig. 41, is *C. ovata*, Eichwald. See 'Bullet. Soc. Imp. Nat. Mosc.,' 1857, p. 308; and Eichwald's 'Leth. Ross.,' p. 1344.

[2] Published in the Russian language.

[3] M. d'Eichwald has described specimens having the dimensions of 1 by $\frac{1}{4}$th line.

[4] Compare *Cytheropsis concinna* (?), 'Annals Nat. Hist.,' April, 1857, p. 254, pl. 9, fig. 3.

evidently varies very much, being sometimes obsolete; indeed, at first I thought to class it with *Cytheropsis* (see above, p. 38, *note*).

Beyrichia Pyrrhæ is very abundant in the greyish marl of the Permian formation near Burakova, in the government of Kazan, and occurs here in company with *Estheria exigua* (*Cytherina Eos,* Eichw.), see pp. 38 and 40.

In treating of the following *Entomostraca* I have much hesitation in assigning them to definite genera and species, as their hinge-lines and other specialities are, for the most part, unknown. Figs. 13 to 15, 20 to 25, and figs. 31 to 34 may be either *Cytheres, Cyprides,* or *Candonæ,* and there are but few distinctive features among them, whether they be of Carboniferous age (figs. 13, 14, 15), of Rhætic (figs. 20—24), of Jurassic (fig. 25), or of Wealden (figs. 31—34); amongst these last, tangible differences are best seen. Comparing figs. 13 and 14 with figs. 20 and 21, we see similar-looking carapace-valves from the Coal-measures of England and the Lower Mesozoic deposits of Virginia; and, allowing for the possible effects of pressure and imperfection of the margins of the valves, it is somewhat hazardous to attempt to define their specific characters. A glance at Plate I and Plate IV of my 'Monograph of the Tertiary Entomostraca of England,' 1856, will give an idea of the recent and tertiary forms that most closely resemble those under consideration. Among those referred to, however, *Candona* (of freshwater habitat) is the genus which supplies the chief analogies; and as the habitats of *Estheriæ* seem to me to have been mostly freshwater, the associated fossil *Cypridæ* may be provisionally referred to *Candona.* I do not, however, deny that some of them may have been *Cytheres* (but even then they may have affected fresh or brackish water); nor that, being *Candona,* they may not have been able to live in saltish water (as *Cypridæ* do occasionally, see above, p. 8).

The following *Cypridæ* are figured with what appears to be the anterior extremity upwards; and the more convex of the two long margins is regarded as the dorsal.

3. Candona (?) Salteriana, sp. nov. Pl. V, figs. 13, 14.

Length, $\frac{1}{19}$ inch. Breadth, $\frac{1}{45}$ inch.

Carapace-valve smooth, elongate-oval, with nearly straight ventral and dorsal margins. Fig. 13 has both extremities somewhat obliquely curved; fig. 14 has one end nearly semicircular; and this was probably the natural condition, as is usual in this group. The antero-dorsal slope in fig. 14 may have been exaggerated by pressure. This Cyprid is, in size, intermediate between *Candona Forbesii* and *C. Richardsoni* of the Eocene deposits ('Tert. Entom.,' p. 18, pl. 4, figs. 8—12). Although little is known about it, yet it is advisable to give it a distinguishing name; and none can be better than one derived from

the ardent palæontologist who found it and introduced it to me, who has so carefully studied the fossils of the Coal-measures, and who has contributed so much to the materials of this Monograph.

Candona (?) *Salteriana* occurs in the shales of the Four-foot Coal, Bradford Pit, near Manchester (see page 32). These belong to the Upper Coal-measures, and contain, besides *Estheria tenella,* a shell named *Unio Phillipsii* by Prof. Williamson, but now regarded as an *Anthracomya* by Mr. Salter, and remains of *Lepidodendron Sternbergii.*

4. Candona (?) Tateana, sp. nov. Pl. V, fig. 15.

Length, $\frac{1}{48}$ inch. Breadth, $\frac{1}{90}$ inch.

A small, smooth, oval carapace-valve, somewhat crushed, occurs with *Estheria striata,* var. *Tateana,* at Lammerton, Berwickshire (see p. 27). This, for the sake of distinction, though it is but poorly defined, may be denominated *Candona* (?) *Tateana*, after the enthusiastic geologist to whom we are indebted for its discovery.

North American Lower Mesozoic Cypridæ.

In the numerous notices of the Estherian and Carbonaceous shales of Pennsylvania, Virginia, and North Carolina, by the State-geologists and others, to which reference is made in the account of *Estheria ovata* given above (pp. 84—99), frequent mention is made of the *Cypridæ* found in some of those shales. These have been generally termed "Cyprides," and sometimes "Cytheres" and "Bairdiæ" (Emmons). As they have come under my observation whilst studying *Estheria ovata,* I now proceed to describe them by the help of specimens kindly submitted to me by the Professors W. B. and H. D. Rogers and Mr. Wheatley. For the same reasons that I assigned the above-described Cyprid from the English Coal-measures to the recent genus *Candona* (with some doubt), I here refer the very similar North American Mesozoic forms to the same genus, but with less hesitation, as the carapace is better preserved; and, from their general features and habit, I have no doubt that they are either *Cypris* or *Candona,* most probably the latter. There appear to be two species, one having a smooth, the other a pitted, carapace; and this distinction we may provisionally accept as specific until we find individuals occurring partially punctate or otherwise intermediate in character.

5. Candona (?) Rogersii, sp. nov. Pl. V, figs. 20, 21, 22.

Cypris, *W. B. Rogers.* Proceed. Boston Soc. Nat. Hist., 1854, vol. v, 15.
— *J. Leidy.* Proc. Acad. Nat. Sci. Phil., June 16, 1857, p. 150.
— *Wheatley.* Amer. Jour. Sci. Arts, 2nd ser., 1861, vol. xxxii, p. 42.

Bairdia, Cypris, } *Emmons.* American Geology, part vi, 1857, pp. 39 and 56.

Length, $\frac{2\frac{1}{2}}{72}$ inch. Breadth, $\frac{1}{72}$ inch.

Carapace-valves smooth, oblong, rounded at the extremities, but narrower and obliquely rounded anteriorly; ventral margin straight, dorsal slightly arched; hinge-line simple, as in *Candona*. It is difficult to find a well-preserved and well-exposed specimen on the shales. Fig. 21 is slightly deformed by pressure on the dorsal curves. Fig. 22 is a cast of a narrowish or compressed carapace; were it broader, it would better represent the common typical form. Fig. 20 is a young individual. The two figured specimens correspond with the two figured by Dr. Emmons in his 'American Geology,' part VI, p. 39, fig. 10. A slight, flat, marginal rim is often apparent, except on the anterior border (fig. 21).

This is very similar to fig. 14, excepting in size; but the very great difference in geographical and geological position weighs with me in supposing that this may be specifically distinct from its Palæozoic and European analogue on one hand, and from its Eocene analogues (*C. Forbesii*, &c.) on the other. As it is an abundant fossil in the Lower Mesozoic Estherian shales of Virginia and North Carolina, and present in those of Pennsylvania, it is well that it should have a distinct name, and none can be better than one derived from the two eminent brothers who have worked so well on the geology of those regions.

The chief specimens that I have seen (lent to me by Messrs. Rogers) are from Virginia (Culpepper County, and Prince Edward, near Richmond) and from North Carolina (Deep River). Those from near Richmond are in black carbonaceous shale; the valves are numerous on the bed-planes, single, smooth, thin, calcified, and more or less crushed, varying in length from 1-24th inch downwards; the smaller ones appear to be less tapering at the anterior end than the other; but they are all, I have no doubt, of the same species. Those from Deep River are in a similar black shale, and altogether like those from Richmond above described; and there are traces of *Estheria* [1] amongst them. The specimens from Culpepper Co., Virginia, consist of casts and moulds crowded in red shale (on bed-planes), associated with *Estheria*.

I have also met with this smooth *Candona* (?) in the Pennsylvanian shales which were

[1] These fragmentary *Estheria* certainly appear to be *E. ovata*, and so far supply the wanting link in my argument respecting the specific identity of the *Estheriæ* from the several localities. (See p. 91.)

sent to me by Mr. Wheatley (see above, p. 93), particularly in a hard red shale. It appears, however, to be rare in some of these shales, for in a black shale, showing the *Cypridæ* in good preservation, there are but one or two of these associated with a multitude of the pitted *Candona* (*C. Emmonsii*). Some of these Estherian and Cypridiferous shales from Phœnixville, however, are largely made up of indistinguishable *Cypridæ*, and the smooth form may be abundant enough in several of the beds.

Dr. E. Emmons, in his 'American Geology,' part VI, notices the abundant occurrence of these *Cypridæ* "in the Chatham series of Deep and Dan Rivers;[1] they are also abundant in the black shales of Halifax County, Va., in the same geological position" (p. 39). This author terms some of them "Bairdiæ:"[2] but they certainly do not belong to that sub-genus of *Cythere;* and the "lobulated" condition of the valves, as described and figured by him (figs. 10 and 11, pp. 32, 40), is due merely to crush and fracture; others he seems to think may belong to *Cypris*[3] (pp. 39 and 54). He also observes that these "minute Crustaceans frequently fill entire strata. The individuals are about 1-30th of an inch long. They have the form of a bean, and their carapaces are smooth. They differ in size; some are about half the length of the largest, and appear to be equally numerous with the larger. They are numerous in all the upper part of the black shales.[4] About seventy feet above the coal-seam they become rare, and, indeed, I believe, are not to be found below the level" (p. 39). "They do not exist at all in the immediate vicinity of the coal-seams" (p. 40). They are abundant in some strata and absent in others.

In the "Upper Red Sandstone and Marls (Keuper), Chatham Co., North Carolina, about seven miles south of Egypt [Deep River, North Carolina], there are Cyprides also, which are quite numerous upon certain soft red layers" (p. 134).

6. Candona (?) Emmonsii, sp. nov. Woodcut, fig. 12.

Cypris; granulated species (?), *Rogers.* Proceed. Boston Soc. Nat. Hist., vol. v, p. 15.
— „ *Wheatley.* Amer. Jour. Sci. and Arts, 2nd ser., 1861, vol. xxxii, p. 44.

Length, $\frac{1}{36}$ inch. Breadth, $\frac{1}{72}$ inch.

In one of the hard black shales sent from Phœnixville by Mr. Wheatley is a layer of *Cypridæ*, well preserved, their interior being filled with calcite, and their convex crusts retaining perfect shape, and showing a neatly punctate surface, marked with minute sub-

[1] See above, p. 90.

[2] Because he regards the formation to be either marine or brackish, and because he supposes the valves to have the hinge-joint of *Bairdia.*

[3] At p. 31 Dr. Emmons, it seems, refers all these Entomostracans to *Cythere.*

[4] See the section of the black shales at Egypt Pit, Deep River, p. 89.

hexagonal pits, with something like the pattern of the outside of a thimble, an ornament common among bivalved Entromostracans. These specimens, though numerous, are scarcely ever clearly exposed out of the matrix on all sides, so it is difficult to get at their real outline, which seems to be just that of *C.* (?) *Rogersii.* (See woodcut, fig. 12.)

FIG. 12.

Candona (?) Emmonsii, *from Pennsylvania. Magnified* 30 *diameters.*

One, and perhaps two, of the last-named species occurs on the same block, but in a different layer. As is the case sometimes with *C. Forbesii,* these carapaces lie crowded together, for the most part parallel or nearly so one with another, a circumstance due, perhaps, to the action of a slight current in the water at the bottom of which they were deposited.

This is probably the so-called "granulate" species referred to by Rogers and Wheatley (see above, p. 94).

What I have stated at pp. 91 and 92 respecting the probability of the chief Estherian and Carbonaceous shales of North Carolina, Virginia, and Pennsylvania, being on one geological horizon, and of the upper Estherian shales of Deep River being of essentially the same age, though separated from the others by upwards of 1800 feet of bedded rocks,[1] will apply to the *Cypridæ* now under notice.

Whether or not these deposits have a Keuperian character, as Prof. O. Heer's late determination of the Coal-plants from Richmond, Va., seems to indicate, there is no doubt of their being the products of lagoons in the Lower Mesozoic period, and contemporary either with the marine formation intermediate to the Trias and Lias,[2] namely, the Rhætic, or with the Upper Trias itself, and exactly equivalent to the Letten-Kohle[3] (carbonaceous shales at the base of the Keuper).

7. CANDONA (?) GLOBOSA, *Duff,* sp. Pl. V, figs. 23, 24.

CYPRIS GLOBOSA, *Duff.* Geology of Moray, 1842, p. 16.

Length, $\frac{1}{30}$ inch. Breadth, $\frac{1}{60}$ inch.

Carapace sub-cylindrical, smooth; carapace-valves oblong, straight on the ventral edge, slightly arched on the dorsal, rounded at the ends, but obliquely at the antero-dorsal region, so that the fore end is narrower than the other. Lucid spots (muscle-mark) apparent, like those of *Candona Forbesii* ('Monog. Tert. Entom.,' p. 18).

[1] Usually regarded as of that *vertical* thickness (see *note,* p. 91).

[2] The coal-beds of Steierdorf, Banat, appears to belong either to the Lower Lias or the Rhætic formation.

[3] See above, pp. 46, 49, &c. I am strongly inclined to coincide with Mr. Hislop in his views as to the age of the beds in India that have yielded *Estheria Mangaliensis* (see p. 78), and to regard them as "Upper Triassic" (p. 79), instead of "Rhætic" (p. 81), if we must find an exact European equivalent for them.

This must be the Cyprid referred to by Mr. Duff in his description of the shales at Linksfield, where *Estheria minuta*, var. *Brodieana*, occurs (see above, p. 67). Although the trivial name is not the best that could be found for it (as its oblong form hinders its convexity from making it globose), yet I will not interfere with the name given by its first observer.

This Rhætic *Candona* is very like the Tertiary *C. Forbesii* and other closely allied forms, including the Mesozoic *C. Rogersii* and the recent *C. reptans*, its relative size and proportions making but little real distinction. It is well, however, that it should have a distinctive name for convenience of geological grouping.

C. globosa occurs in great numbers, and in many laminæ, in the greyish calcareous shale or marl at Linksfield; and *Estheria minuta*, var. *Brodieana*, sometimes appears on the same bed-plane.

8. Candona Kotahensis, sp. nov. Pl. V, fig. 25.

> Cypris, *Hislop*. Quart. Journ. Geol. Soc., 1861, vol. xvii, pp. 348 and 353; Journ. Bombay Asiatic Society, 1861, vol. vi, p. 201.

Length, $\frac{1}{30}$ inch. Breadth, about $\frac{1}{60}$ inch.

Carapace sub-cylindrical, smooth; carapace-valves oblong, with equally rounded ends; dorsal margin neatly rounded in front and behind.

This *Candona* is plentiful with *Estheria Kotahensis* in shale at Kotah, on the Pranhita, Central India (see p. 52). It is found also in a limestone there.

The same general resemblances are to be observed for this form as in the case of *C. globosa*, *C. Rogersii*, &c. As it is advisable that we should be able to recognize it by name, I give it one, though its slight difference of outline is the only tangible feature of distinction.

9. Cypridea Valdensis, *Sowerby*, sp. Pl. V, figs. 26—30.

> Cypris Faba, *Sowerby* (not *Desmarest*). Annals Philos., 1824, vol. viii, p. 376; Min. Conch., p. 485.
> Cypris Valdensis, *Sowerby*. Trans. Geol. Soc., 2nd ser., 1829, vol. iv, p. 177 and p. 344, pl. 21, fig. 1.
> — — *Dunker*. Monogr. Norddeutsch. Wealdenbildung, 1846, p. 59, pl. 13, figs. 24, 29.

Height, about $\frac{1}{32}$ inch. Length, about $\frac{1}{25}$ inch.

Valves of this Cyprid, both with and without the antero-ventral notch, occur

abundantly in the Wealden shales of Hanover (with *Estheria;* see above, p. 104), as we find them in England also, both in the Weald Clay and the Purbeck Beds. The variations in size, shape, and surface-condition, such as are shown in figs. 26—30, with others intermediate, are also met with in England.

M. Bosquet judiciously proposed the term *Cypridea* for these Wealden *Cypridæ* ('Descript. Entom. Tertiair.,' 1850, p. 48); and I have already pointed out ('Monogr. Tert. Entom.,' 1850, p. 9 & p. 21) that they are related to the recent *Cyprideis,* which, though probably a sub-genus of *Cythere,* inhabits fresh and brackish water.

10. Cypridea oblonga (?), *Roemer,* sp. Pl. V, figs. 31—34.

Cypris oblonga, *Rœmer.* **Verstein. Nordd. Oolithengeb. Nachtrag, 1839, p. 52, pl. 20, fig. 21.**

— — *Dunker.* **Monog. Nordd. Wealdenbild., 1846, p. 60, pl. 15, fig. 26.**

In company with *C. Valdensis,* this narrower form occurs plentifully in the Wealden shale of Hanover (with *Estheria*); and although in the specimens I have examined I cannot detect the antero-ventral notch, it may still exist in some, as figured by Dr. Dunker. Fig. 33 is most like the form illustrated in the 'Monogr. Nordd. Weald.;' but I think that variation of growth and modification by pressure may have given rise to the somewhat similar valves figs. 31, 32, and 34. These are all freely mixed on some planes of the shale, and seem to offer intermediate gradations, even into *C. Valdensis,* with which they also occur. They are, moreover, generally much crushed, and their margins are not clearly exposed.

Figs. 31 and 34 are not unlike the *Candonæ* noticed in the foregoing pages and figured in Pl. V, but for the present I propose to leave them as here arranged, hoping for a future opportunity of elucidating all the Wealden *Cypridæ.*

INDEX.

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SUPPLEMENTAL NOTES

TO THE

MONOGRAPH OF THE FOSSIL ESTHERIÆ.

I. The recent *Estheriæ*, *E. Dunkeri*, *E. Jonesi*, *E. Loftusi*, *E. Caldwelli*, *E. Rubidgei*, and *E. Macgillivrayi*, and *Limnetis Gouldii* (p. 7), have been described and figured by Dr. Baird in the 'Proceedings of the Zoological Society' for 1862, p. 147, &c., pl. 15.

II. With reference to the probability of some fossil *Estheriæ* still passing as *Aviculidæ*, &c. (p. 13), it should be remarked that Prof. M'Coy has already intimated that some fossils regarded as Molluscs may prove to be Entomostraca ('Synopsis of the Carboniferous Fossils of Ireland,' 1842, p. 164).

III. Another locality for *Estheria membranacea* (p. 14) is Banniskirk, Caithness.

IV. To the list of localities for *Estheria minuta* in Germany, enumerated at pages 41, 50, 55, &c., several may be added from C. W. Gümbel's 'Geognostische Beschreibrung des bayerischen Alpengebirges und seines Vorlandes' (8vo, Gotha, 1861), a national geological work of great value. Besides the classification of the Triassic beds of Würtemberg, given at pp. 46—49 of the 'Monograph,' we now have the grouping of the Bavarian Trias, for comparison with that of Alsace (p. 53) and England (pp. 62—65); and this is the more interesting as *Estheria minuta* occurs in two of the divisions of the Trias in the Bavarian Alps, and at least in one (the Bunter) on the south side of the Alps.

Herr Gümbel thus groups the members of the Alpine Trias of Bavaria:

I. Keuper	Upper Keuper or Rhætic Group	1. Upper Keuper-limestone (Oberer Keuperkalk oder Dachsteinkalk); with *Megalodus triqueter*. 2. Upper Shell-keuper (Oberer Muschelkeuper); with *Avicula contorta* and the Bone-bed.	Kössen and Gervillia Beds.
	Middle Keuper or Dolomite Group	1. Plattenkalk; with *Rissoa Alpina*. 2. Hauptdolomit. Dachstein-Dolomit. 3. Gyps und Rauhwacke.	
	Lower Keuper or Lettenkohle Group	1. Lower Shell-keuper (Unterer Muschelkeuper); with *Cardita crenata*. [*Estheria minuta*.] Raibl Beds. 2. Lower Keuper-limestone (Unterer Keuperkalk); with *Monotis salinaria* and *Ammonites globosi*. [*E. minuta*.] Hallstätt Beds, Esino-limestone, &c. 3. Lettenkeuper, shales and sandstone; with *Halobia Lommeli* and *Pterophyllum longifolium*. [*E. minuta*.] Partnach and St.-Cassian Beds.	

II. Muschelkalk. (*Encrinus liliiformis*, &c.) Guttenstein-limestone, &c.

III. Buntsandstein Formation . .
1. Haselgebirgschichten; with Gypsum and Rocksalt. [*E. minuta*?]
2. Buntsandstein; with *Myophoria vulgaris* and *Myacites Fassaensis*. [*E. minuta*.]
3. Alpenmelaphyr (Trap-rocks).

The analogous groups of strata in the Tyrol and other parts of the Alps are indicated by Herr Gümbel's tables at pages 116 and 192.

Gümbel states that *Posidonomya minuta* [*Estheria minuta*] occurs in the "Buntsandstein" on both sides of the Alps (pp. 155 and 181); that it occurs in the Lettenkeuper of the Bavarian Alps, at the Partnachthal-Enge (p. 219); in the Lower Keuper-limestone at the Heiterwand, near Imst (p. 225); in the Lower Shell-keuper at the following localities:—"Wettersteinalp bei Garmisch; Hinterriessthal am grossen Falken; Fermesbach unter Schlageck; Hochalpe unter der Alpspitze; Gasfeld am Daumen im Algäu" (p. 273).

V. In treating of the history of the deposits containing *Estheria ovata* (pages 84 *et seq.*), by inadvertence no mention is made of the opinions expressed by M. Jules Marcou as to the age of these beds. In the 'Bulletin de la Soc. Géol. de la France,' 2e sér., vol. vi, 1849, and in his 'Geological Map of the United States' (Boston, 1853), M. Marcou referred the Coal-formation of Richmond, Virginia, to the Lias or the Keuper. In his "Résumé explicatif d'une carte géologique des États-Unis," &c., 1855 ('Bull. Soc. Géol. France,' 2e sér., vol. xii), he referred this coal to the Keuper. In his 'Lettre sur la Jura,' Zurich, December, 1857, after noticing Prof. Emmons's views of the age of the Coal-formation of Eastern Virginia and of North and South Carolina (see 'Monograph,' p. 90), he states that he had himself referred it to the New Red Sandstone series, in 1853, and that Von Buch held the same opinion. In his 'Geology of North America,' 4to, Zurich, 1858, he referred the Red Sandstone of Connecticut, &c., and the Coal-formation of Eastern Virginia, &c., to the Keuper, and, in a note at p. 13, gave a history of his opinions on the subject (with remarks on those of the Profs. Rogers); and here he also quoted O. Heer's remarks on the Triassic relationship of some fossil plants collected by him in Chesterfield County, Virginia, and C. Bunbury's reasons for having been induced, in 1847, to regard the Virginian fossil plants as Liassic (some specimens being imperfect, and the Basle and Baireuth plant-beds being at that time classed with the Lias). In his 'Reply to the Criticisms of J. D. Dana,' 1859, M. Marcou, in mentioning the "New Red in North Carolina and Virginia," again refers to Prof. Heer's letter on the fossil plants, and explains how it passed into 'Silliman's American Journal.' Lastly, in his 'Dyas et Trias,' 1859, he quotes and accepts Prof. Emmons's classification of the strata of the Carolina Coal-formation as Triassic and Permian, and explains at large his opinion that the Permian and Trias ought to be regarded as one great system, belonging rather to the Secondary or Mesozoic than to the Palæozoic period.

PLATE I.

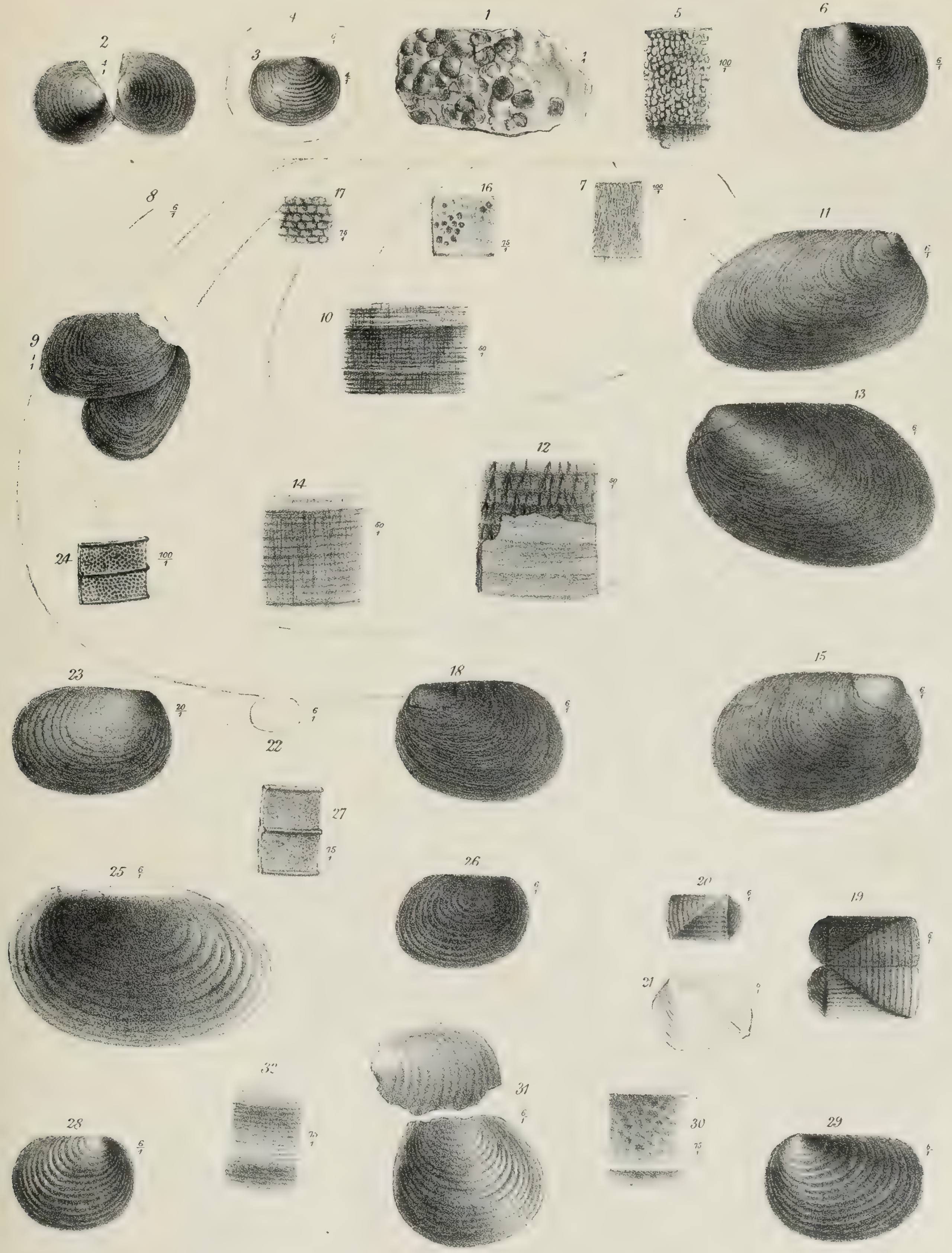
FIG.

1. *Estheria membranacea* (p. 14).—A group on sandy flagstone, nat. size. Caithness.
2. „ „ A pair of valves, open, and somewhat displaced; their dorsal edges approximate; the ridges lost in wrinkles: × 4 diam. Caithness.
3. „ „ A single valve (right): × 4 diam. Caithness.
4. „ „ Outline of the same valve, × 6 diam., for comparison with other *Estheriæ* magnified 6 times. Caithness.
5. „ „ The surface between two ridges, × 100 diam. Probably showing the effects of sand-grains interfering with the natural ornament. Caithness.
6. „ „ Left valve, well preserved, from Kokenhusen, Livonia: × 6 diam.
7. „ „ Ornament of an interspace of the same: × 100 diam.
8. *Estheria striata*, var. *Binneyana* (p. 28).—From near Chesterfield, Derbyshire; outline of valve: × 6 diam.
9. „ „ „ A pair of displaced valves; nat. size. Near Chesterfield.
10. „ „ „ Portion of the surface: × 50 diam. Chesterfield.
11. *Estheria striata*, var. *Beinertiana* (p. 25).—Right valve from Shaly Brow, Lancashire: × 6 diam.
12. „ „ „ Portion of the surface of the same, showing the nearly smooth outside, and the wrinkled interior: × 50 diam.
13. „ „ „ Left valve; from Silesia: × 6 diam.
14. „ „ „ Portion of the surface of the same: × 50 diam.
15. *Estheria striata*, var. *Tateana* (p. 26).—Right valve; Lammerton, Berwickshire: × 6 diam.

16, 17. „ „ Cellular structure, remaining in the shale; Lammerton: × 75 diam.

18. „ „ „ Left valve of a shorter individual; Lammerton: × 6 diam. [A still shorter form is shown in the woodcut at p. 26.]
19. *Leaia Leidyi*, var. *Williamsoniana* (p. 117).—The inside view of two conjoined valves; Ardwick, Manchester: × 6 diam.
20. „ „ „ Right valve, outside; Ardwick: × 6 diam.
21. *Leaia Leidyi*, var. *Salteriana* (p. 119).—Outline of left valve; Fifeshire: × 6 diam.
22. *Estheria exigua* (p. 37).—Right valve. (Probably young.) Kargala, Russia: × 6 diam.
23. „ „ The same valve: × 20 diam.
24. „ „ Portion of the surface: × 100 diam.
25. *Estheria Portlockii* (p. 40).—Hollow mould of right valve; Rhone Hill, Tyrone: × 6 diam.
26. *Estheria tenella* (p. 31).—Right valve; Oschatz, Saxony: × 6 diam.
27. „ „ Portion of the surface of the same: × 75 diam.
28. *Estheria minuta* (p. 42).—Right valve, its ridges lost in wrinkles; Sinsheim: × 6 diam.
29. „ „ Left valve of a larger and better preserved specimen; Sinsheim: × 6 diam.
30. „ „ Portion of the surface of another specimen, showing the reticulated interspace between the ridges: × 75 diam.

31, 32. *Inoceramus* (*Posidonomya*) *Suessii*, Oppel (p. 12).—From the bluish shale of the Lower Oolite (zone of *Ammonites torulosus*), Kandern, Baden; for comparison with *Estheria minuta*. Fig. 31, portion of a valve, and mould of a part of another: × 6 diam. Fig. 32, portion of the surface: × 75 diam. (This shell occurs also in the Oxford Clay near Peterborough.)



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FOSSIL ESTHERIÆ, &c.

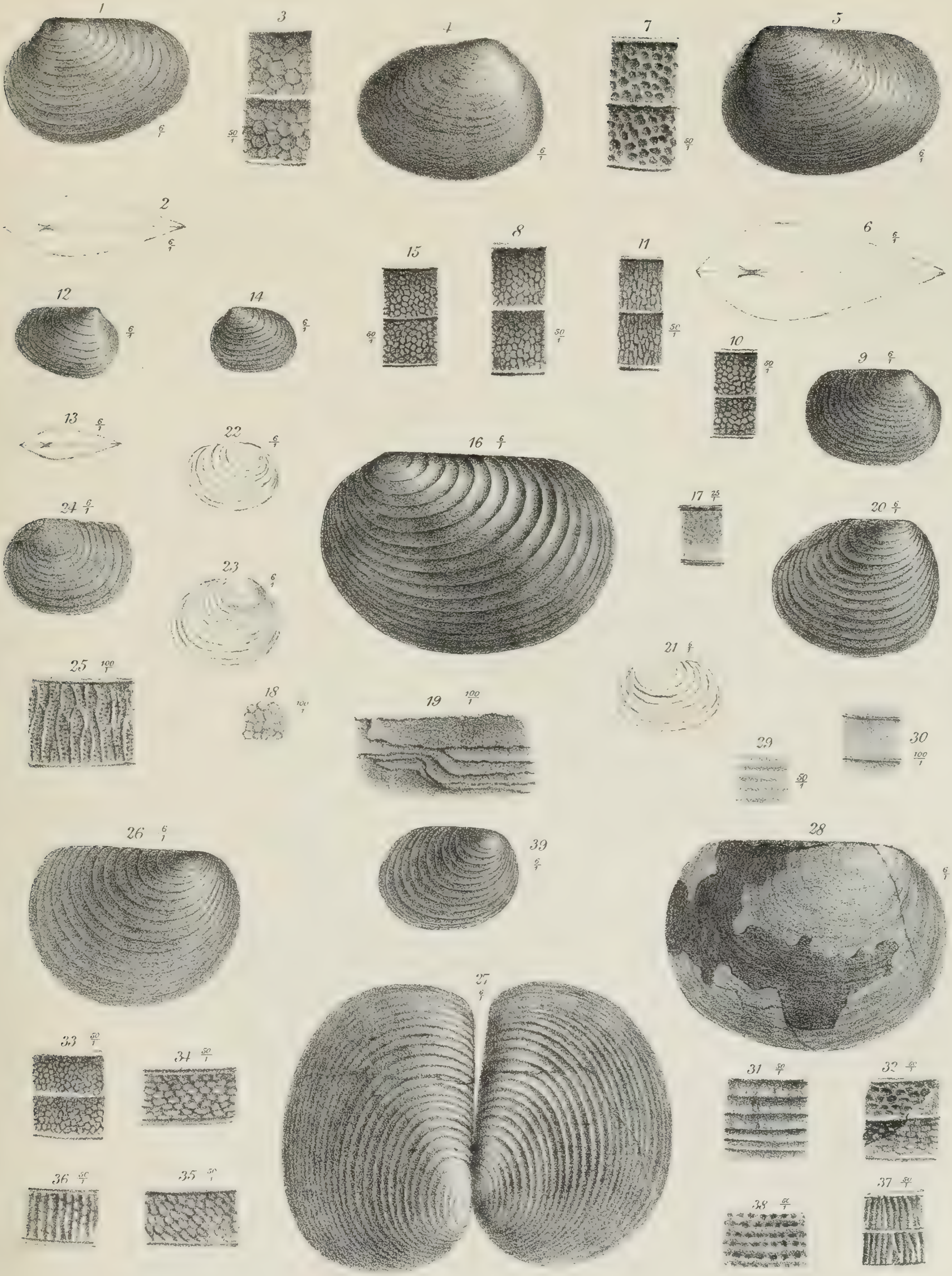
PLATE II.

Fig.

1. *Estheria minuta.*—Left valve, well-preserved; Pendock, Worcestershire: × 6 diam.
2. ,, ,, Dorsal profile of the same: × 6 diam.
3. ,, ,, Portion of the surface of the same: × 50 diam.
4. ,, ,, Right valve; Somerton, Somersetshire: × 6 diam.
5. ,, ,, Left valve; Shrewley, Warwickshire: × 6 diam.
6. ,, ,, Dorsal profile of the same: × 6 diam.
7. ,, ,, Portion of the surface of the same: × 50 diam.
8. ,, ,, Portion of the surface of a specimen from Frome, Somersetshire, showing a smaller reticulation: × 50 diam.
9. *Estheria minuta,* var. *Brodieana* (p. 66).—Right valve; Linksfield, Elgin: × 6 diam.
10. ,, ,, ,, Portion of the surface of the same: × 50 diam.
11. ,, ,, ,, Portion of the surface of another specimen, from the same place, showing a more linear reticulation: × 50 diam.
12. ,, ,, ,, Right valve; Wainlode, Gloucestershire: × 6 diam.
13. ,, ,, ,, Dorsal profile of the same: × 6 diam.
14. ,, ,, ,, Left valve, from the same place: × 6 diam.
15. ,, ,, ,, Portion of the surface of another specimen, from the same place: × 50 diam.
16. *Estheria Mangaliensis* (p. 78).—Left valve; Mangali, Central India: × 6 diam.
17. ,, ,, Portion of the surface: × 25 diam.
18. ,, ,, Portion of an interspace: × 100 diam.
19. ,, ,, Portion of the surface where the ridges are lost in overlapping laminæ: 100 diam.
20. ,, ,, Right valve of a subquadrate individual: × 6 diam.
21. ,, ,, Left valve of a young individual, ovate-oblong: × 6 diam.
22. ,, ,, Right valve of a young individual, subovate: × 6 diam.
23. ,, ,, Right valve of a young individual, subquadrate or suborbicular: × 6 diam.
24. *Estheria Kotahensis* (p. 81).—Left valve; Kotah, on the Pranhita, Central India: × 6 diam.
25. ,, ,, Portion of surface: 100 diam.
26. *Estheria ovata* (p. 84).—Right valve of a youngish individual; Prince Edward, near Richmond, Virginia: × 6 diam.
27. ,, ,, A pair of valves (somewhat restored); Prince Edward, Richmond: × 6 diam.
28. ,, ,, Right valve; Harding's pit, near Richmond, Virginia: × 6 diam.
29. ,, ,, Portion of the surface of the same: × 50 diam.
30. ,, ,, Portion of the surface of the same: × 100 diam.

31—38. ,, Portions of the surface: × 50 diam. Figs. 31, 32, 33, 36, and 38, are from Richmond; figs. 34, 35, and 37 are from Dan River.

39. *Estheria tenella* (p. 31).—Right valve; Lanarkshire: × 6 diam. (For its ornament, see Pl. V, fig. 7.)



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FOSSIL ESTHERIÆ.

PLATE III.

FIG.

1. *Estheria Murchisoniæ* (p. 100).—Right valve; Isle of Skye: × 6 diam.

2. ,, ,, Smaller specimen: × 6 diam.

3–12. ,, ,, Portions of the surfaces, mostly of different specimens: × 50 diam.

13. *Estheria concentrica* (p. 101).—Left valve; Scarborough: × 6 diam.

14. ,, ,, Dorsal profile of the same.

15. ,, ,, Portion of the surface: × 50 diam.

16. ,, ,, Outline of the right valve of the specimen shown at fig. 13: nat. size.

17. ,, ,, Outline of a larger specimen: nat. size.

18. *Estheria elliptica*, var. *subquadrata* (p. 109).—Right valve; Bulverhithe, Sussex: × 6 diam.

19. ,, ,, ,, Another specimen (left valve) from Bulverhithe: × 6 diam.

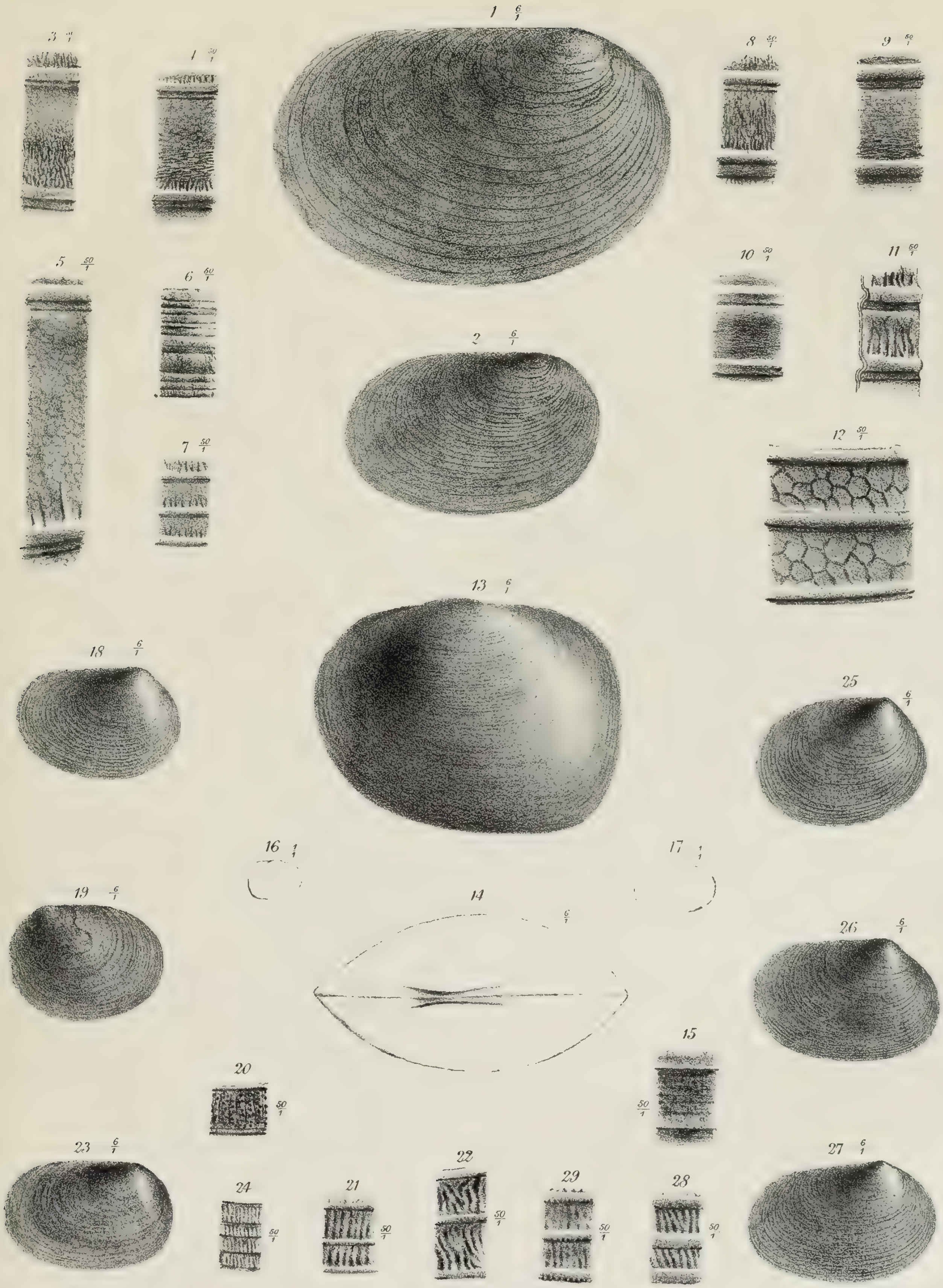
20—22 ,, ,, ,, Portions of the surface of specimens from Bulverhithe: × 50 diam.

23. ,, ,, ,, Right valve; Tunbridge Wells: × 6 diam.

24. ,, ,, ,, Portion of the surface: × 50 diam.

25—27 ,, ,, ,, Right valves; East Cliff, Hastings: × 6 diam.

28, 29. ,, ,, ,, Portions of the surfaces of the same: × 50 diam.



George West lith ad nat

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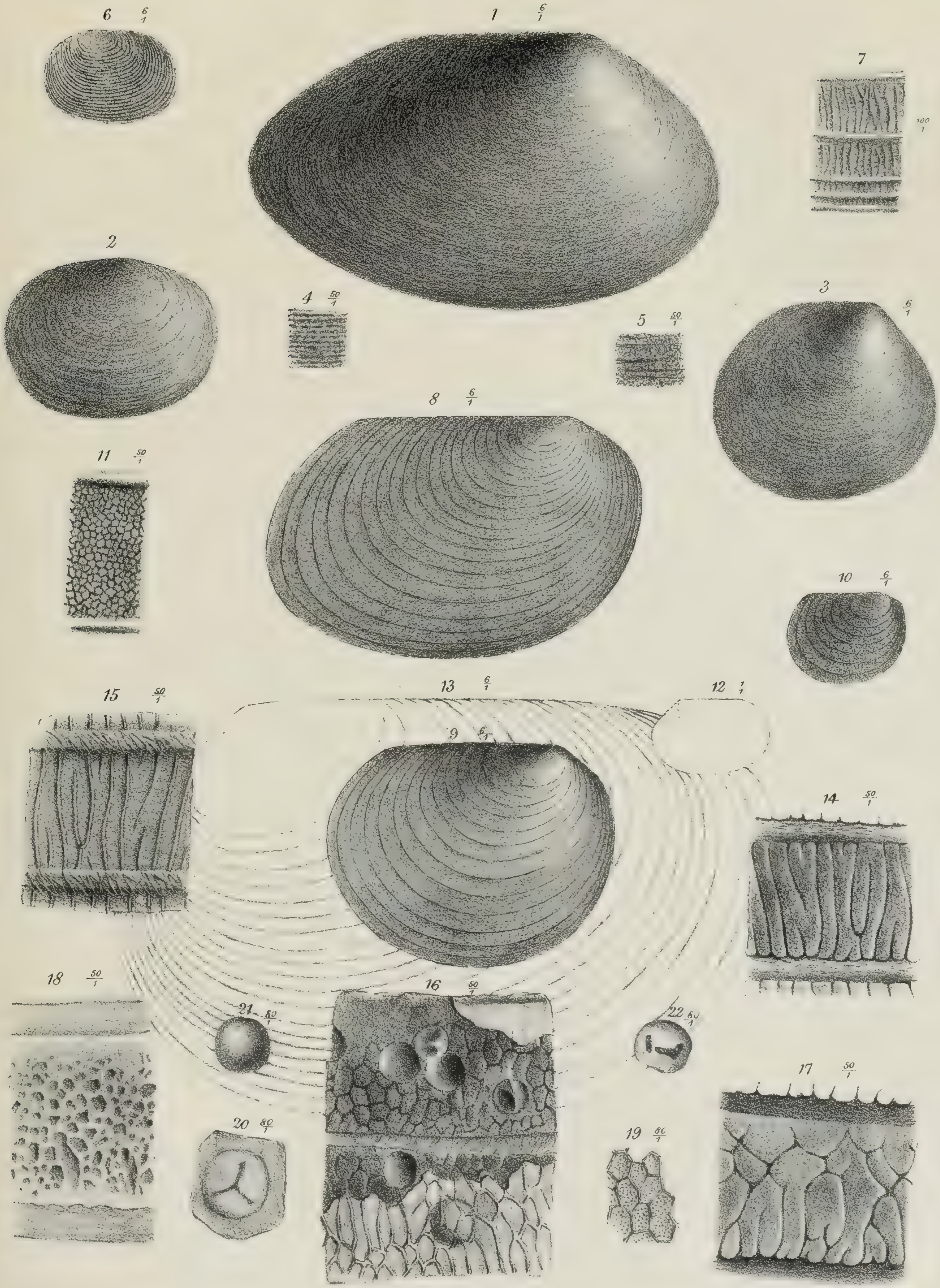
FOSSIL ESTHERIÆ.

PLATE IV.

Fig.		
1.	*Estheria elliptica* (p. 103).	Right valve; Obernkirchn, Hanover: × 6 diam.
2.	,, ,,	Right valve of a smaller individual, subquadrate or ovate-oblong: × 6 diam.
3.	,, ,,	Right valve of a suborbicular individual: × 6 diam.
4, 5.	,, ,,	Portions of the surface of fig. 1: × 50 diam.
6.	,, ,,	Left valve of small individual, ovate-oblong or subquadrate, with distinct ridges: × 6 diam.
7.	,, ,,	Portion of the surface of the same, taken from near the ventral edge: × 100 diam.
8.	*Estheria Forbesii* (p. 109).—	Right valve; Cacheuta, South America: × 6 diam.
9.	,, ,,	[Within the outline of *E. Middendorfii.*] A smaller suborbicular specimen: × 6 diam.
10.	,, ,,	A still smaller individual: × 6 diam.
11.	,, ,,	Portion of the surface of fig. 8: × 50 diam.
12.	*Estheria Middendorfii* (p. 111).—	Outline of the left valve; Tourga, Siberia: nat. size.
13.	,, ,,	Outline of the same: × 6 diam.
14.	,, ,,	Natural cast, in shale, a portion of the surface: × 50 diam.
15.	,, ,,	The surface-ornament restored from the cast, fig. 14: × 50 diam.
16.	,, ,,	Portion of the surface, including parts of two interspaces, one of which is partly occupied by the real carapace, the other being almost all a cast or impression in shale; the globular bodies and casts are referable to ova: × 50 diam.
17, 18.	,, ,,	Natural casts or impressions of portions of the carapace; fig. 17 corresponding to such a portion as the lower part of fig. 16: × 50 diam.
19.	,, ,,	Portion of the reticulated surface: × 80 diam.
20—22.	,,	Some of the oviform bodies: × 80 diam.



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FOSSIL ESTHERIÆ.

PLATE V.

Fig.

1. *Estheria tenella* (p. 31).—Left valve, small specimen; Bradford Coal-pit, near Manchester: × 6 diam.

2, 3. ,, ,, Other larger specimens (left and right valves): × 6 diam.

4. ,, ,, Portion of the surface of one of these: × 75 diam.

5. ,, ,, Left valve; Astley, Lancashire: × 6 diam.

6. ,, ,, Right valve; Murgthal, Schwarzwald: × 6 diam.

7. ,, ,, Portion of the surface; Lanarkshire: × 100 diam. [See Pl. V, fig. 7, for the valve, × 6 diam.]

8. *Estheria minuta* (p. 42).—Right valve; Sinsheim, Baden: × 6 diam. [For comparison with Pl. I, figs. 28 and 29.]

9. ,, ,, (p. 53.)—Left valve; Sulzbad, Bas-Rhin: × 6 diam.

10. *Estheria minuta*, var. *Brodieana* (p. 66).—Portion of the surface, showing linear reticulation; Linksfield: × 50 diam. [Compare Pl. II, figs. 9—11.]

11. *Leaia Leidyi* (p. 116).—Outline of the two valves, open, in juxtaposition; Pottsville, Pennsylvania: nat. size. [After Lea.]

12. ,, ,, The same: × 5 diam. [After Lea.]

13, 14. *Candona* (?) *Salteriana* (p. 122)—Bradford Coal-pit, near Manchester: × 30 diam.

15. *Candona* (?) *Tateana* (p. 123).—Lammerton, Berwickshire: × 30 diam.

16. *Beyrichia subarcuata* (p. 120).—Astley, Lancashire: × 30 diam.

17. ,, ,, Portion of the surface: × 75 diam.

18. *Beyrichia Pyrrhæ* (p. 121).—Burakova, Russia: × 30 diam.

19. ,, ,, Portion of the surface: × 75 diam.

20, 21. *Candona Rogersii* (p. 124).—Richmond, Virginia; and Deep River, North Carolina: × 30 diam. [For the punctated *Candona Emmonsii*, see woodcut, fig. 12, p. 126.]

22. ,, ,, Cast, in shale; Culpepper County, Virginia: × 30 diam.

23, 24. *Candona globosa* (p. 126).—Linksfield, Elgin. Two left-hand valves, showing muscle-spot: × 30 diam.

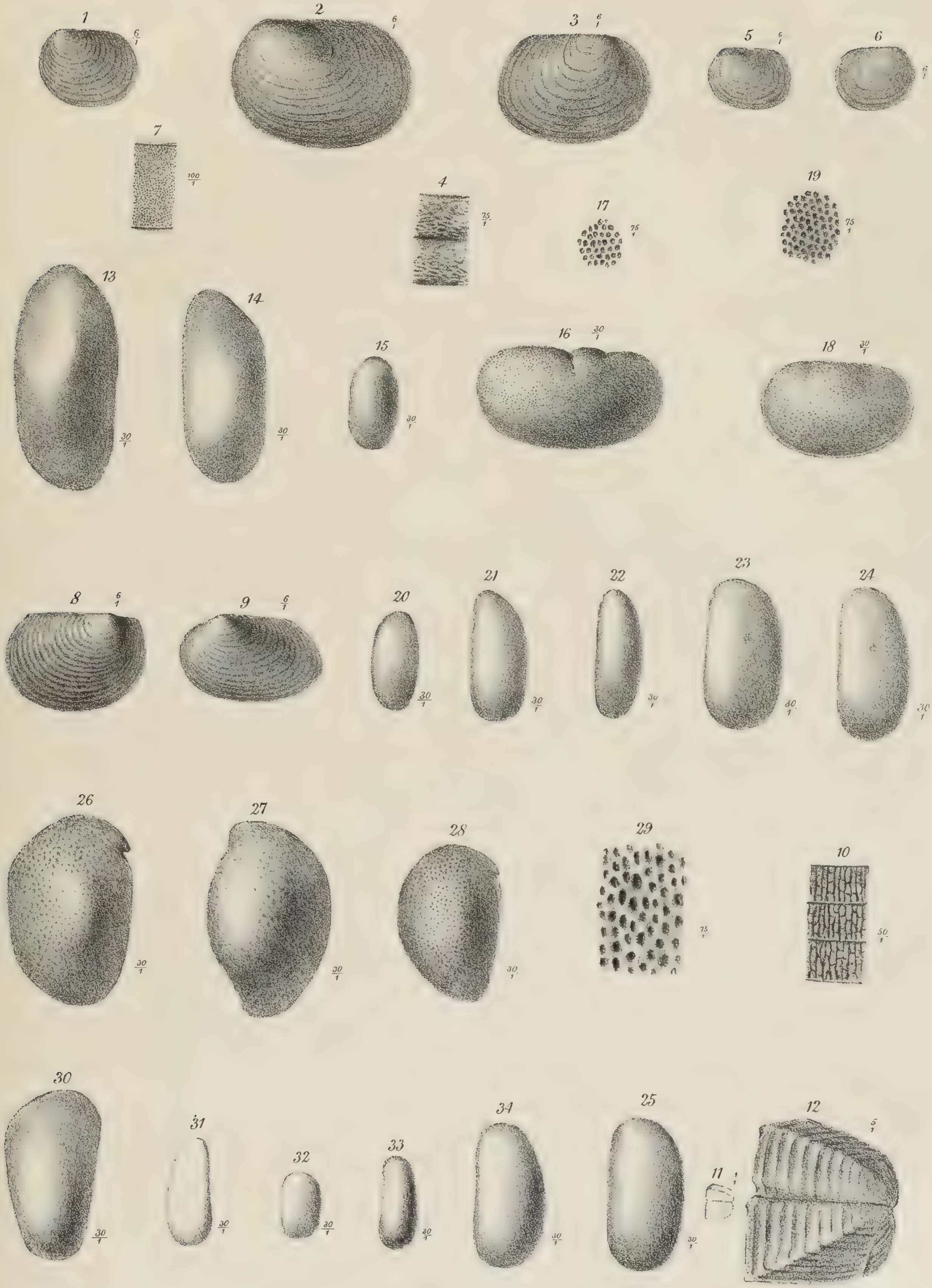
25. *Candona Kotahensis* (p. 127).—Left valve; Kotah, on the Pranhita, Central India: × 30 diam.

26—28. *Cypridea Valdensis* (p. 127).—One right and two left valves, of somewhat variable outline; Obernkirchn, Hanover: × 30 diam.

29. ,, ,, Portion of the surface of one of these valves: × 75 diam.

30. *Cypridea Valdensis* (?).—Probably a young individual; Obernkirchn: × 30 diam.

31—34. *Cypridea oblonga* (?) (p. 128). Probably varieties or modified valves (fig. 33 is most like the type); Obernkirchn, Hanover: × 30 diam.



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FOSSIL ESTHERIÆ, CYPRIDÆ, &c.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLXII.

A MONOGRAPH

OF THE

FOSSIL

MALACOSTRACOUS CRUSTACEA

OF

GREAT BRITAIN.

BY

PROFESSOR BELL, F.R.S., F.G.S., ETC.,

LATE PRESIDENT OF THE LINNEAN SOCIETY.

PART II.

CRUSTACEA OF THE GAULT AND GREENSAND.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1862.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

PREFACE.

The Crustacea of the strata below the Chalk, which form the subject of the present portion of this work, present several remarkable peculiarities in their forms and affinities. One of the most interesting of these is the existence of analogous or, so to speak, representative species in these beds and in the London Clay, on the Crustacea of which I have already treated. In some cases this representation is shown in their specific distinction, with the most perfect generic identity, as in the case of *Hoploparia*, of which we have already seen two very distinct species in the later formation, and we have now described no fewer than six species in the earlier deposits. In no instance do any of these locally separated individuals belong respectively to the same species; in every one the specific distinctness is unambiguous, but the generic relation to each other is no less so. Another case, of nearly similar import, occurs in the anomurous family Dromiadæ; the *Homolopsis* of the Greensand being represented in the London Clay, by two species of *Dromilites*, a very nearly allied form.

These examples are extremely interesting when associated with the fact that, as far as our present information extends, there is no form in the whole immense bed of the Chalk proper, which at all approximates those which are respectively found in the beds which it separates by such an incalculable epoch and such an enormous space.

Such facts as these are extremely suggestive, as bearing upon important questions

which have recently occupied anew the attention of naturalists, and they deserve to be well considered and compared with analogous examples, which doubtless present themselves in other formations and in other groups of organized beings.

The investigation of any fossil species is often met by a difficulty which demands some consideration, as showing how necessary it is that the inexperienced palæontologist should not be prejudiced by the striking discrepancy which is often found in the appearance of different specimens of the same species, from different localities. As the animals are ordinarily found in a very imperfect and often in a fragmentary condition, this caution becomes the more important; and in no group of animals is the difficulty greater than in the Crustacea, the specific, and even the generic characters of which are often so subtle or so minute, as to require the closest observation of a practised eye to appreciate them. The mineral character of the bed in which the specimens are found is so strongly impressed upon them, that a limb from one locality, an abdomen from another, and a carapace from a third, can scarcely be recognised by one unaccustomed to the work as even possibly belonging to an identical species. This is strikingly shown in *Hoploparia scabra*, which is found under extremely various aspects in the Gault, the Greensand of the neighbourhood of Cambridge, and that of Wiltshire.

In the present part I have the opportunity of describing a third species of the oxyrhynchous form, of which group, as before observed, not one was known in a fossil state when Professor Milne Edwards published his great work on the Crustacea. The first ever ascertained was the *Mithracia libinioides* of the former part of this work; Mr. Charles Gould afterwards described a second, *Mithracites vectensis*, found in the lower Greensand of the Isle of Wight; and the third, *Trachynotus sulcatus*, a very remarkable form from the upper Greensand of Wiltshire, is now for the first time described.[1]

In the various collections of the Crustacea of the Gault and Greensand, to which I have enjoyed the freest access, there is one circumstance which is extremely tantalising. This is the occurrence of numerous specimens of the limbs of these animals, often in a very perfect state, but found in situations so totally separated from any other important part that it is impossible to appropriate them to any hitherto known species, or to describe them with any certainty as belonging to any determinate genus. This is particularly the fact in Mr. Carter's fine collection of Cambridge Greensand Crustacea and in that of Mr.

[1] Page 2, pl. i, fig. 2.

Cunnington from Wiltshire. It is earnestly to be desired that these gentlemen, and all others who, with similar ardour and success, investigate the Crustacean remains of their respective localities, will endeavour to remedy as far as possible this lamentable deficiency, and I trust that I may thus be enabled, in a supplement to the third and concluding part of this work, to give a satisfactory description of various species, to which belong numerous beautiful specimens of limbs, which I have been obliged, most reluctantly, to return to their kind owners undescribed and unemployed.

I cannot close these few remarks without again offering my cordial acknowledgments to my friends who have most liberally aided me in this portion of my work, and especially to the two gentlemen above named, to Dr. Bowerbank, to the Messrs. Woodward, of the British Museum, to Mr. Norman, of Ventnor, to the Council of the York Museum, and to Mr. Dallas, the curator of that collection, who have, without reserve, placed their invaluable collections at my disposal, and thus contributed to the completion, or rather to the very existence of a work which, but for their kind assistance, could never have seen the light.

The Wakes, Selborne;
March 3, 1862.

ERRATA IN PART I.

It is particularly requested that the following corrections be made with the pen at page v of the Introduction :—Foot-note, four lines from the bottom of the page, after B b, *instead of* "mesogastric," *read* "mesobranchial;" after B c, *for* "metagastric," *read* "metabranchial;" after C a, *for* "epigastric," *read* "epicardiac;" after C b, *for* "metagastric," *read* "metacardiac."

Page vii, line 6, *for* "Cyclocoryster," *read* "Cyclocorystes."

Page 38, line 3, the quotation from Davila should be transferred to the synonyms.

Explanation of Plate VI, *add*—"11. Male abdomen of the same."

MONOGRAPH

OF THE

FOSSIL MALACOSTRACOUS CRUSTACEA

OF

GREAT BRITAIN.

PART II.—Of those found in the Greensand and Gault.

Order—*BRACHYURA.*

Family—MAIADÆ.

Genus—Mithracites, *Gould.*

Char. Gen. Testa suborbicularis, anticè æquè arcuata, vix longior quam latior, regionibus distinctis; rostro æquè longo ac lato, anticè obtusè triangulari; *orbitæ* transversim suboblongæ; *oculorum peduncula* ad latera rostri inserta.

Mithracites vectensis, *Gould.* Plate I, figs. 2, 3.

Descr. The carapace is suborbicular, of nearly equal length and breadth, including the rostrum; the anterior portion almost evenly arcuate, the latero-posterior margin somewhat bulging; the rostrum very distinct, projecting, of equal length and breadth, grooved in the middle, terminating in an obtuse triangle, with the anterior edge a little raised; the regions mostly distinct, and somewhat tumid, the nuchal and hepatico-branchial sulci rather deep; the whole surface minutely tuberculated, and having large, distinct tubercles on the different lobes of each region; of these there are about five on the median line and seven on each side, viz., one on each epigastric lobe immediately behind the rostrum, one on the mesogastric, one on the hepatic region, and four on the branchial.

Length and breadth of the carapace, 0·6 inch.

Obs. The above description is taken from two specimens, existing respectively in the British Museum and in Dr. Bowerbank's collection, in each of which the carapace alone remains. The difficulty which necessarily exists in obtaining good generic characters from such slight data is but too well known and too often felt by every palæontologist; and it is especially the case in the class of Crustacea, where the generic characters are ordinarily derived from parts which are most easily destroyed, and which, even when existing in a perfect condition, require the most acute discrimination to detect their essential structure and determine their physiological bearing and importance.

This species was first described by my friend, Mr. Charles Gould, in the 'Quarterly Journal of the Geological Society,' published in May, 1859, where he has the following observations:—"I regard the Crustacea, which I am about to describe, with peculiar interest, on account of its belonging to the group of the Brachyura, which comprehends the highest forms of the class, and of which hitherto but one species (*Mithracia libinioides*, Bell*) has been described as occurring in the fossil state in Great Britain."

All the specimens hitherto known are from the lower Greensand in the Isle of Wight.

Genus—TRACHYNOTUS, *Bell.*

Species unica. TRACHYNOTUS SULCATUS. Plate I, fig. 1.

Descr. Carapace convex, subrhomboidal, with rounded angles, rather broader than long, the transverse diameter widest immediately behind the mesobranchial lobes; the portion anterior to the nuchal furrow occupying scarcely one third of the entire area; the surface is covered with small tubercles, which, for the most part, are irregularly arranged in rows upon transverse ridges, which are separated by strongly marked furrows; the nuchal furrow in its course across the carapace bends a little backwards, forming a very obtuse angle; a second furrow, parallel with it, extends entirely across the carapace, and a third, crossing the mesobranchial lobe, terminates by passing forwards into the one anterior to it, at some distance from the median line. The metagastric lobe forms a regular rhomb, its anterior process is linear and extends to the front; the latero-anterior margin is rounded and without teeth or other armature, the latero-posterior margin is hollowed, and the posterior has a narrow, slightly raised, border.

Length of carapace, 0·5 inch; breadth, 0·6 inch.

From the upper Greensand of Wiltshire.

Obs. Of this singular species I have seen but two specimens, one in the British

* 'Monogr. Foss. Malac. Crust. Gr. Brit.,' Part I, "Crustacea of the London Clay," 1858, p. 9, pl. v, figs. 10—12.

Museum and the other in Mr. Cunnington's collection. The absence of all the parts upon which generic distinctions depend has necessitated my confining myself to a description of the carapace. Its nearest affinity to any recent form appears to be to the genus *Mithrax*, and particularly to that division of the genus which is represented by *Mithrax denticulatus* and *Mithrax sculptus*, both of which in form and general aspect it considerably resembles. Its principal interest consists in its being another of the few examples of the occurrence of a Maian form in a fossil state, the first, *Mithracia libinioides*, having been recorded in the first part of this work.

Family—CANCERIDÆ.

Genus—Xanthosia, *Bell*.

Char. Gen. *Testa* multo latior quam longior, fronte lato, undulato, emarginato; margine latero-anteriore quadridentato seu quadrilobato. *Orbitæ* distantes, magnæ, rotundo-ovatæ, suprâ atque infrâ obscurè bifissæ.

Xanthosia Gibbosa, *mihi*. Plate I, figs. 4—6.

Margine latero-anteriore dentibus quatuor triangularibus.

Descr. Carapace nearly twice as broad as it is long, considerably convex, the anterior part granulated, the posterior punctate; front broad, waved, emarginate, depressed in the centre; latero-anterior margin with four triangular teeth; the anterior regions elevated, particularly the proto- and meso-gastric lobes; the nuchal furrow nearly transverse. Orbits distant, large, of a rounded oval form, without teeth or other armature, the margin slightly raised, and both above and beneath with two very small, indistinct fissures.

Length of carapace, 0·7 inch; breadth, 1·2 inch.

Three specimens are in Mr. Cunnington's collection, from the upper Greensand of Wiltshire.

Obs. In its general aspect this species so much resembles many of the genus *Xantho*, and especially that section of it which is represented by *Xantho florida* of our coasts, that at first sight I thought it might be considered as belonging to that genus. Notwithstanding, however, the absence, in all the specimens observed, of most of the parts on which generic characters depend, the greater breadth of the carapace in proportion to its length, the greater distance of the orbits from each other, their larger size and more simple structure, the greater

breadth of the front, and the more even transverse direction of the nuchal furrow, indicate a difference between the two forms which I consider sufficient to warrant a distinct generic place.

The resemblance is still so striking in the general form of the carapace, the existence of four triangular teeth on the latero-anterior margin, and the waved outline of the front, that I have thought it desirable to express the similarity in the name applied to it. The genus *Xantho* itself, as it was left by Prof. Milne Edwards, requires a complete revision, and ought probably to be considered as comprising three or four genera, an arrangement which that distinguished naturalist suggests by the sections which he has himself indicated.

XANTHOSIA GRANULOSA, sp., *M'Coy.* Plate I, fig. 13.

Margine latero-anteriore lobis quatuor obtusis.

REUSSIA GRANULOSA, *M'Coy.*

With some hesitation I have referred the species indicated, but neither figured nor described, by Prof. M'Coy, under the name of *Reussia granulosa,* to the present genus, instead of that to which the author had assigned it. The specimens which I have had an opportunity of observing are scarcely sufficient to supply me with any satisfactory characters, but such as exist lead me to consider the species as more nearly allied to *Xanthosia* than to *Reussia* of M'Coy. The general form of the carapace is very similar to that of the foregoing species, but the latero-anterior margin, instead of having four rather acute teeth, has that number of obsolete lobes; this margin also extends somewhat further back than in the former. The regions are very well marked, and are even more gibbous than in *X. gibbosa.* The carapace is evenly covered with minute and regular granulations.

Length of the carapace, 0·7 inch; breadth, 1·2 inch.

It has hitherto been found only in the upper Greensand of Cambridge, where it is very rare. The specimen figured, and from which the above imperfect description is taken, is in Mr. Carter's collection.

Genus—ETYUS, *Mantell.*

Char. Gen. *Testa* transversìm elliptica, bis ferè latior quam longior, tuberculata, sulco nuchali transverso fere recto in medio divisa. *Orbitæ* oblongæ, approximatæ, suprà tuberculis tribus subtùs excavatis armatæ. *Pedes* longi, gracilis.

Species unica. Etyus Martini, *Mantell.* Plate I, figs. 7—12.

Etyus Martini, *Mantell.* Med. of Creat., p. 322, fig. 1. Geol. S.E. of Engl., p. 169, fig. 1. Morris, Cat., p. 58.
Reussia granosa, *M'Coy.* Ann. Nat. Hist., 1854. Contr. to Brit. Pal., p. 271, fig. 4.

Descr. Carapace twice as broad as it is long, nearly plane from side to side, moderately convex from front to back; the anterior margin forming a perfect segment of a circle, and armed with three or four tubercles; the latero-posterior margin somewhat hollowed; the anterior portion of the carapace, including the gastric and hepatic regions and the metabranchial lobes, covered with small, sharp tubercles and granules of different sizes; the posterior portion simply granulated; a larger distinct tubercle exists on each mesogastric and one on each mesobranchial lobe. The nuchal furrow is almost directly transverse, dividing the carapace into two nearly equal portions. The proto-, epi-, and meso-gastric lobes are confused, and but slightly separated from the hepatic; metagastric lobe triangular, the anterior process extending forwards to the front; the urogastric rather large, without any tubercle, and but slightly distinguished from the cardiac region. The epibranchial lobe very distinct, gibbous, strongly tuberculated; the mesobranchial somewhat pear-shaped, with a single, strong tubercle on the anterior part; the metabranchial without tubercles; the branchial sulci distinct. Orbits transverse, oval, open to the antennary fossæ, and separated only by a thin septum, where the front descends to meet the narrow, triangular epistome; the upper margin of the orbits has three tubercles, which are excavated underneath in a very peculiar manner. Fragments of several of the legs remain in one specimen in my possession, which show that they were long, slender, and smooth.

Length of carapace, 0·4 inch; breadth, 0·8 inch.

Found plentifully in the Gault, at Folkestone, in Kent; at Ringmer, in Sussex; and rarely in the upper Greensand at Cambridge. Specimens exist in the British Museum, in those of the Geological Survey and Cambridge, and in Dr. Bowerbank's, my own, and other collections.

Obs. The affinities of this species cannot be very satisfactorily determined by the characters which are available in the imperfect specimens which have hitherto been observed. There is, however, no ground whatever for considering it as an anomurous form, as suggested, with a query, by Prof. Morris, in his 'Catalogue.' It is undoubtedly strictly brachyurous, and probably belongs to the great group of Canceridæ, according to the classification of our great carcinologist,* but its nearer affinities require an examination of many organs which do not exist in any known specimens to be accurately determined.

* Edw., 'Nat. Hist. Crust.,' vol. i.

The history of the name which has been given to this genus is somewhat curious. On obtaining specimens of several species of Crustacea from the Gault, Mantell applied to Dr. Leach, as the highest authority on the subject, for information respecting their affinities. In the present case the naturalist, misled by a superficial resemblance, gave his inquirer the name of *Etisus*, a well-known recent genus; and as caligraphy was not one of my distinguished friend's qualifications, Mantell doubtless read the word *Etyus*, published it as on Leach's authority in two, at least, of his works, and *Etyus* it became. I hesitated whether it was desirable to perpetuate a name which was only not erroneous because it was a blunder, but on consideration it appeared that it would be inconvenient to change a generic term which had become sanctioned by long use and frequent repetition.

This amusing mistake in nomenclature is, however, not the most important error which has occurred in relation to this species. On examining the collection of Gault and Greensand Crustacea at the Museum of Practical Geology, I was struck with the number of specimens which were marked *Reussia granosa* of M'Coy, the whole of which, including some from Cambridge, I found were specimens, more or less worn, of *Etyus Martini*. This circumstance led me to investigate more closely the description given by that author of the genus *Reussia* and of the species *granosa*, and I soon became perfectly satisfied that this genus has been founded upon a few worn specimens of the present species, and must, therefore, be reduced to a mere synonym. If it were wished to select an example of the extreme dissimilarity between different representations of the same subject, which so often occasions trouble and mistake to naturalists, and not unfrequently leads to glaring errors, it would be scarcely possible to select one more striking than is afforded by a comparison of the wretched woodcut in Mantell's 'Medals' of *Etyus Martini*, with the engraving of M'Coy's *Reussia granosa* in his 'Contributions to Palæontology.' Nothing short of a critical examination of the specimens themselves could lead any one to suppose their identity.

There is in Mr. Carter's collection a fragment of a carapace which differs in some respects from the normal form of *E. Martini*. The latero-anterior margin has four lobes, which are not furnished with the sharp tubercles which are usually observed on this part. There are, however, similar tubercles on the anterior portion of the carapace, the distribution of which differs somewhat from their ordinary arrangement.

I give a figure of the specimen in Plate I, fig. 12.

Genus—Diaulax, *Bell.*

Species unica. Diaulax Carteriana, *mihi*. Plate I, figs. 14—16.

Descr. Carapace very minutely and uniformly granulated, somewhat broader than it is long, its greatest breadth immediately in front of the nuchal furrow; very convex from

before backwards, very slightly so from side to side; the regions very indistinctly marked, the protogastric lobes with a small, almost obsolete tubercle, the posterior median portion of the gastric and the cardiac region slightly raised. There are two parallel, shallow furrows extending nearly straight across the carapace; the boundary line of the anterior one, the nuchal furrow, forming a distinctly marked edge; the posterior furrow is in some specimens almost obsolete. At the lateral margins the sides of the carapace form a sharp angle with the upper surface; there is a small tubercle on the lateral margin immediately in front of the nuchal furrow, and a rather larger one behind it; the latero-anterior margin is somewhat curved, the latero-posterior nearly straight. The front is simple, somewhat incurved, depressed in the centre; the orbits oval, transverse, distant, being separated by a wide antennary fossa, which is open to the orbit. The upper margin of the orbit is entire; in the lower margin is a rather broad groove. The epistome is pentagonal, and the angles are much produced. The claw, of which only a fragment has been found, is extremely large in proportion, is robust and quite smooth; the hand round and gibbous, and as broad as it is long; the moveable finger carinated above. Of the ambulatory legs nothing remains but the basal portions, and from these it appears that the last pair are placed on a much higher level than the others. There are no remains in any of the specimens I have seen of footjaws, antennæ, or abdomen.

Length of carapace, 0·9 inch; breadth, 0·7 inch.

Found in the upper Greensand of Cambridge, from which there are specimens in Mr. Carter's collection and in my own.

Obs. The extremely imperfect state of all the specimens hitherto found of this species has deterred me from attempting to offer any formal generic character, and the same circumstance renders it very doubtful to what group of recent Crustacea it is most nearly allied. Mr. Carter has suggested to me its probable affinity to the Thelphusadæ, and, certainly, the general form of the carapace, the wide oval orbit, and the robust claw, would seem to sanction this opinion; but in the absence of all those organs by which the essential relations of a group are indicated, I can scarcely admit into a family, of which all the known species inhabit the banks of rivers in the interior of the countries where they are found, a species so entirely confined to a bed of strictly marine origin. I have, therefore, assigned to it a provisional place amongst the Canceridæ, without attempting, with our limited means of forming a judgment, to decide upon its more intimate relations. It is one of the rarest forms in the prolific bed of the Cambridge upper Greensand, there being but few specimens even in Mr. Carter's fine collection of fossil Crustaceans from this locality. I have dedicated it to that gentleman, to whom I am indebted for first bringing it to my notice, and for the loan of the specimens from which my description and figures are derived.

Genus—Cyphonotus, *Carter*, MS.

Char. Gen. Testa subglobosa, latior quam longior, fronte triangulari, depresso, incurvo, regionibus indistinctis, sulco nuchali triangulari, margine latero-posteriore obliquè truncato. *Orbitæ* oblongæ, obliquæ, supra integræ.

Species unica. Cyphonotus incertus, *mihi*. Plate I, figs. 17—19.

Descr. Carapace subglobose, the anterior margin forming nearly a semicircle, the surface very even, covered with small granulations of various sizes; the regions undefined; front triangular, bent downwards, and somewhat incurved at the apex; latero-anterior margin with an acute edge, and with four or five slight indentations; latero-posterior margin obliquely truncated and tuberculated; nuchal furrow forming an obtuse-angled triangle; a second, inconspicuous furrow extends transversely across the branchial regions and between the gastric and cardiac, tending slightly forwards, so as nearly to meet the nuchal furrow on the median line. Orbits oblong, oblique, open to the antennary fossæ, each partially divided by a very slight ridge, both on the margin and on the inner surface, answering to the depression at the point where the eye joins its peduncle, when laid at rest within the orbit. The upper margin of the orbit entire.

Length of carapace, 1·3 inch; breadth, 1·0 inch.

In Mr. Cunnington's collection, from the upper Greensand of South Wiltshire, and in Mr. Carter's, from that of Cambridge.

Obs. The peculiarities of this species, and the imperfect condition of the few specimens hitherto found, are such as preclude any very certain appreciation of its affinities. The general *primâ facie* aspect of the carapace would lead to the impression that it belongs to the great group of the Canceridæ, and probably to that section of it of which the genus Carpilius is the tpye; but on a closer inspection the oblong form of the orbits, with their partial division and oblique direction, the strongly depressed, incurved, and triangular front, and some other characters, appear to forbid this view, and I am compelled to leave the question without any suggestion as to its true solution.

A tolerably perfect carapace exists in Mr. Cunnington's collection from the upper Greensand of the neighbourhood of Horningsham, in South Wiltshire, and several fragments from the Cambridge bed are in the possession of Mr. Carter. I have adopted the generic name assigned to it by the latter gentleman in his MS.

Family—PINNOTHERIDÆ.

Genus—Plagiophthalmus, *Bell.*

Char. Gen. *Testa* oviformis, valdè convexa, lævis, margine omninò integerrimo. *Orbitæ* minimæ, elongatæ, obliquæ, intra testæ marginem positæ.

Species unica. Plagiophthalmus oviformis, *mihi.* Plate II, figs. 1—3.

Descr. Carapace evenly egg-shaped, very convex, the height from the plane of the lateral margin being equal to nearly half of the length; the front slightly produced and bent downwards; the surface smooth; the nuchal furrow shallow, and a second furrow, nearly parallel with the former, extending across the carapace between the meso- and meta-branchial lobes and across the cardiac region; a small, bifurcate, impressed line passing backwards from the front for a short distance on the carapace. Orbits very small, elongate oval, placed obliquely within the margin, and appearing as if pierced in the substance of the carapace. In the two specimens observed there is nothing remaining but the carapace, which is tolerably complete in each.

Length of carapace, 0·6 inch; breadth, 0·5 inch.

There are two specimens from the upper Greensand of Wiltshire in the collection of Mr. Cunnington, and three in the British Museum from the same locality.

This is certainly one of the most interesting fossil species I have yet met with. Its form is very remarkable, being as nearly as possible that of half an egg, a figure which at once recalls that of *Remipes*, a resemblance, however, which is not borne out by any important characters. It is very unlike the figure of any species with which its essential characters would appear to associate it; but the uniformity and smoothness of the carapace, the slight indications which exist of regional distinctions, and, above all, the form, situation, and direction of the orbits, appear to me to indicate a near approach to certain forms of the Pinnotheridæ. The genera to which I consider it as most nearly allied are *Xenophthalmus* of White and my genus *Amorphopus*. In the last-named form the orbits are placed within the frontal margin of the carapace, but open forwards where the sides slightly approach each other anteriorly; in *Xenophthalmus* the orbits are extremely small, placed far within the margin, and the sides of the orbit completely close in front, so as to have given to the original describer of the genus, the idea that the orbits were actually pierced through the carapace. In the present equally remarkable form the orbits appear *primâ facie* to be absolutely excavated in the substance of the carapace.

Family—LEUCOSIADÆ.

Genus—Hemioön, *Bell.*

Char. Gen. Testa ovalis, elevata, lateribus declivibus, anticè producta, truncata. *Orbitæ* parvæ, cylindricæ, antrorsum apertæ. *Oris apertura* angustè ovata.

Species unica. Hemioön Cunningtonii, *mihi.* Plate II, figs. 4—7.

Descr. The carapace is of an elongate oval form, somewhat produced anteriorly, the front truncated, the sides sloping, very convex from side to side, nearly straight from before backwards; the surface very smooth, extremely minutely granulated, the regions very slightly indicated; the lateral margin forming a continuous and even curve. The orbits are placed on the outer side of the fronti-orbital opening, and are nearly cylindrical; and the eyes must have had a forward direction, as in the rest of the family. The oral aperture is very narrow, ovate, elongate, narrowing forwards, and open to the antennary fossa, without any intervening epistome. The Pterygostomian process obliquely sulcated. From the size of the basal joints of the legs which remain in a small specimen in my possession, it appears that the limbs must be somewhat robust. The abdomen in the male is narrow, linear, and the only segments which remain, the first four, are all separate.

Length of the carapace, 0·6 inch; breadth, 0·4 inch.

Two specimens exist in Mr. Cunnington's collections from the upper Greensand of Wiltshire, a very small one in that of Mr. Carter, of Cambridge, and one in my own; both these are from the upper Greensand of Cambridge.

Obs. The peculiar interest which attaches to the present species consists in its being the only example of a fossil Leucosian hitherto discovered in this country, if we except *Ebalia Bryeri,* a not uncommon living species inhabiting our coasts, of which Mr. Searles Wood found some remains in the Coralline Crag. Two species, belonging undoubtedly to the family Leucosiadæ, are described by Desmarest.* Of the first of these, *Leucosia cranium,* the author says, "Le mode de conservation de cette fossile est le même que celui que présentent les espèces qui viennent des Indes orientales." This is the only indication given of its locality. Of the second species, *L. subrhomboidalis,* no locality is mentioned. There is a third species, described by the same author under the name *Leucosia Prevostiana,* which does not appear to belong to this family.

The form of the carapace is very peculiar, and differs from that of the Leucosiadæ in general in its proportions, being almost twice as long as it is broad, a proportion

* 'Hist. Nat. des Crust. Foss.,' p. 112 et seq., pl. ix. figs. 10—13.

belonging only to one known recent species, *Myra elegans*;* it is also, with the exception of the slightly projecting frontal and orbital regions, nearly of the form of half an egg, suggesting the generic name which I have given to it. The essential characters are, however, sufficient to establish its true affinities. The uninterrupted smoothness of the surface, the slight projection and truncation of the frontal portion, the small size, position and direction of the orbits, and the form of the oral aperture, all concur in supporting this view of its affinities.

I have named the species after Mr. Cunnington, of Devizes, whose papers on the geology of Wiltshire are well known, and to whose kindness I am indebted for the loan of the whole of his interesting collection of Crustacea from the upper Greensand of that county.

Sub-Order—OXYSTOMATA.

Family—CORYSTIDÆ.

Genus—Palæocorystes, *Edwards, Bell.*

Char. Gen. *Testa* longior quam latior, depressa, posticè gradatim angustior, margine latero-anteriore dentato, rostro brevi. *Orbitæ* latæ, ovales, mediocres, suprà bifissæ. *Pedipalpi externi* caute exteriore lineari, apicem versus angustato; caulis interioris articulo secundo lineari, tertio bis longiore quam latiore. *Pedes antici* æquales; *posteriores* reliquis multo minores. *Abdomen* in utroque sexu segmentis omnibus separatis, quinque prioribus brevibus, sexto quadrato, septimo semiovali.

The carapace in all the species of this genus at present known is strikingly similar to that of the recent species *Corystes Cassivelaunus,* so common on most of our shores. It is considerably longer than it is broad; the front has a small rostrum; the orbits are of moderate size, and have two fissures in the upper margin. The oral opening is rather narrow, and extends forwards to near the point of the rostrum, where it terminates in an acute angle, and the epistome is extremely small. The external footjaws are narrow, both the stalks linear, and the external one pointed and slightly curved at the apex. The third joint of the internal stalk is inserted at the middle of the truncated extremity of the second, and is twice as long as it is broad. The legs are more or less robust, excepting the last pair, which are very much smaller than the preceding ones, and placed considerably above their level. The abdomen has parallel sides, the first five segments are short, the sixth quadrate, and the seventh semioval, approaching triangular. There are no intercalary pieces at the angles of the junction of the sixth and seventh segments.

This genus, to which, from an erroneous notion of the structure of the posterior pair of

* Bell, "Monogr. of the Leucosiadæ," 'Lin. Trans.,' xxi, p. 297, t. xxxii, fig. 4.

legs, Professor M'Coy gave the name of *Notopocorystes*,* was long involved in considerable confusion, arising principally from the total ignorance of the structure of this class of animals on the part of the discoverer of two of the species of which it is composed. In the 'Illustrations of the Geology of Sussex,'† and subsequently in the 'Geology of the South-East of England,'‡ the late Dr. Mantell announced, and in the 'Medals of Creation'§ imperfectly described, a few Crustaceans occurring respectively in the Gault of Kent and Sussex and the upper Greensand of Lyme Regis and Cambridge. In the first instance he submitted the specimens to Dr. Leach, who stated their real or supposed affinity to existing genera. His very brief observations were accompanied in each case by a single phrase on the part of the author of the works above cited, which afforded not the slightest indication as to the true character of the species, the few details given being either nugatory or absurd;‖ whilst the figures in the two earliest of the works mentioned are scarcely recognisable as representations of the creatures to which they refer. The true relation of Mantell's two species of Corystidæ was, however, at once seized upon by Leach, who considered one of them as "intimately related to the typical genus Corystes," and the other as "allied to a new Indian genus of the same family." I shall presently show how correct was this general conclusion.

Taking up the subject at this point, Professor M'Coy gave a full and correct description of *Corystes Stokesii* of Mantell under the name of *Notopocorystes Mantelli*. For what reason he changed the specific name does not appear, as Mantell's name was published four years before M'Coy's, and the latter suggests that they might be identical. The second species is not even alluded to in M'Coy's paper, and he erroneously considers as a species of this genus the *Orythia Bechei* of Deslongchamps, which is designated by Leach as "a new genus allied to Areania," and named by Mantell *Areania Bucklandii*.¶ There are no grounds for considering it as generically allied to M'Coy's *Notopocorystes*, and its relation to *Areania* is obviously still more remote.

In the present work I have the opportunity of describing a third and very beautiful species of the genus now under consideration, *P. Normani*, from the Chalk Marl at Ventnor, in the Isle of Wight.

In the year 1854 Mr. M'Coy published in the 'Annals of Natural History' a description, with figures, of a very interesting Crustacean, which he referred to the same genus, under the name of *Notopocorystes Carteri*, but this I have found it necessary to consider as a new generic form, under the name *Eucorystes*.

* "Etym., νῶτος *dorsum*, πους *pes*, and Corystes." M'Coy, 'Ann. Nat. Hist.,' 1849, p. 169.

† T. xxxix, figs. 9, 10, 15, 16.

‡ P. 109, fig. 2.

§ P. 532, figs. 2, 3.

‖ For instance, as one distinctive specific mark of a *Decapod* species, it is stated that "there are three or four legs on each side!"

¶ 'Medals of Creation,' p. 534. 'Geol. S.E. of Eng.,' p. 169, fig. 3. It is *Necrocarcinus Bechii* of the present work.

The genus, then, as far as regards this country, consists of three species, and the structures which I have found common to them all, and which have been cognizable in the numerous specimens which I have examined, have enabled me to construct the above generic character.*

I have a few observations to make with reference to the true relations of the genus, which, as I have before stated, appear to me to have been misunderstood.

Professor M'Coy—after stating that "in the general form of the carapace, of the rostrum, in the completeness and form of the orbits, with the two fissures in their upper edge, it so exactly resembles *Corystes* as to have even deceived Dr. Leach, the first crustaceologist of his day"—with the greatest confidence refers the genus to the order Anomura, on the single ground of the abruptly smaller size of the last pair of legs, and their being placed on a higher level than the others; whilst he acknowledges that he had not had an opportunity of ascertaining whether there are any supplementary pieces between the sixth and seventh segments of the abdomen, which is by far the more important character. In fact, the small size of the hinder pair of legs, and their elevated position, is a peculiarity which occurs in many other forms of undoubted Brachyura. In the whole family of the Dorippidæ, for example, it is as strongly marked as in any of the Anomura; and in the typical recent species of the present family, *Corystes Cassivelaunus*, this pair of legs is on nearly as high a level, with relation to the preceding ones, as in either of the fossil species. A specimen in the collection of Dr. Bowerbank, in which several joints of the posterior pair of legs exist, shows distinctly that they are not turned over the back at all. Whilst, therefore, I am thus enabled to place the genus in its true relation, I am at the same time compelled to change the name given to it by Professor M'Coy under a mistaken impression as to the structure of these feet. The non-existence in the present species of the intercalary pieces in the abdomen, which are so conspicuous in all the Dromiadæ; including the extinct genus *Dromiolites*, described in the former part of this monograph, forms an additional proof, in the absence of all other anomurous characters, that Leach was not "deceived" when he referred the genus to the family Corystidæ, a view which is confirmed by the structure of the external footjaws and the form of the oral opening.

It is remarkable that the species of this genus are very subject to be infested by a parasite, probably nearly allied to *Bopyrus*, which occasions a large swelling on the branchial region, and doubtless occupied the branchial cavity. This is precisely the situation in which *Bopyrus* is found in several recent species of the Palæmonidæ and their allies, but I

* Two species of this genus have been found on the Continent, both of which are specifically distinct from the British ones. One of these, *Notopocorystes Mulleri* of Count von Binkhorst, considerably resembles *Palæocorystes Broderipii*, and is from the Maestricht beds. The second is *P. Frigeri* of Professor Milne Edwards, which has many characters in common with that species, but is undoubtedly distinct. *Eumorphocorystes sculptus* of the former author has the peculiar sculpture on the carapace which distinguishes *Eucorystes Carteri*, but in the former the sculpture extends over the whole carapace, whilst in the latter it is confined to the anterior half.

do not remember to have seen the same circumstance in any of the existing Brachyura. I have figured a specimen thus infested in Plate III, fig. 3.

Palæocorystes Broderipii, sp., *Mantell.* Plate II, figs. 8—13.

Char. Gen. Testâ depressâ, lævi; margine latero-anterioro tridentato.

Corystes, sp., *Mantell.* Geol. of Sussex, t. xxix, figs. 9, 10. Geol. of the S.E. of Eng., p. 170.
— Broderipii, *Id.* Medals of the Creation, p. 532, fig. 3.
Notopocorystes Broderipii, *Morris.* Cat., p. 111.

Descr. Carapace flattened, smooth, minutely granulated, about one fifth longer than it is broad, becoming gradually narrower backwards from the third lateral tooth; the regions very indistinct; the hepatic with two small depressed tubercles; nuchal furrow extremely shallow and small, placed very far forward on the carapace; the anterior process of the metagastric lobe very narrow and attenuated, extending forward to the base of the rostrum, with a thin sulcus on each side; branchial region occupying two thirds of the whole length of the carapace, separated from the cardiac by a curved furrow; front with a distinctly bidentate rostrum, which is depressed in the middle; orbits extending laterally to near the anterior angle of the carapace, with two fissures and a triangular tooth between them on the superior margin; latero-anterior margin with three strong triangular teeth, including the external orbital process, and a slight projection behind them, from which commences a sharp marginal ridge; the posterior margin hollowed; the pterygostomian processes tumid, sulcated, and with two carinæ, the superior of which has a line of small tubercles. The buccal opening twice as long as it is broad, narrowed forwards, and extending nearly to the base of the rostrum, the epistome being extremely small. External footjaws with the outer stalk slightly curved. The third joint of the inner stalk straight, linear, and flat. The anterior segment of the thorax terminating in three small, flattened processes. Legs similar to those of *P. Stokesii;* the anterior pair short and smooth, the fingers short and inflected, to a degree, however, which varies in different specimens, possibly dependent on sex; the ambulatory legs nearly cylindrical, the third joint with a series of small spines on the anterior side. The abdomen in the male narrower than in the female, carinated, the first segment rather longer than the four succeeding ones; the second, third, fourth, and fifth short, each with a small central spine or tubercle, the sixth forming a large quadrate piece, the seventh triangularly semioval.

Length of carapace, 1·4 inch; breadth, 1·2 inch.

It occurs in the Gault at Folkestone and Maidstone, in Kent, and at Ringmer, in Sussex, in considerable numbers.

Obs. This species was first figured by Dr. Mantell, in the 'Geology of Sussex,' and afterwards in the 'Medals of Creation.' The figures are very inferior, and taken from

very imperfect specimens. Professor M'Coy does not appear to have been aware of these figures, or of the names and description given by Mantell in the 'Medals,' as he makes no mention whatever of this species. It is found in considerable numbers in the Gault at Folkestone, and Dr. Mantell's specimens were from Maidstone, and from Ringmer in Sussex.

PALÆOCORYSTES STOKESII, *Mantell*, sp. Plate III, figs. 1—9.

Testâ tuberculatâ, carinatâ; margine latero-anteriori quadridentato; regionis cardiacæ margine anteriore tuberculo unico instructâ.

CORYSTES, sp., *Mantell.* Geol. Suss., t. xxix, figs. 15, 16. Geol. S.E. Engl., p. 169, fig. 3.
— STOKESII, *Id.* Medals of Creat., p. 532, fig. 2.
NOTOPOCORYSTES MANTELLI, *M'Coy.* Ann. Nat. Hist., 1849, p. 170.
— STOKESII, *Morris.* Cat., p. 111.

Descr. Carapace ovate, carinated, the surface minutely granulated; regions rather more distinct than in the former species, and beset with numerous tubercles, of which there is a regular series of seven or eight on the median carina, those on the cardiac region prominent and sharp, a single one being placed in the centre of its anterior margin; there are three or four conspicuous ones on the lateral lobes of the gastric and on the hepatic regions, and one on the mesobranchial lobe; nuchal furrow deeper than in *P. Broderipii;* the anterior process of the mesogastric lobe very narrow, extending to the base of the rostrum, with a thin sulcus on each side; front terminating in a small bidentate rostrum, which is depressed in the middle, and has two smaller teeth immediately above and behind the terminal ones; orbits of moderate size, not extending so far laterally as in the former species, with two shallow fissures above; latero-anterior margin with four strong, prominent teeth, curved forwards; latero-posterior margin regularly, but very slightly, curved; posterior margin less hollowed than in *P. Broderipii;* pterygostomian process tumid, deeply sulcate, the ridges with numerous tubercles; buccal opening narrower than in the former species. External footjaws with the outer stalk narrow, flat, slightly curved inwards; the inner stalk with the second joint a little wider anteriorly, and longitudinally grooved, the third joint nearly twice as long as it is broad, grooved, and widened forwards, inserted at the middle of the anterior margin of the second joint. The legs are of moderate size, rather long, and varying in thickness in different individuals, which may possibly be dependent upon sex. The claws are somewhat flattened, angular; the arm furnished with a few small tubercles on the outer and inner margin, and two or three near the distal extremity; the wrist is angular, carinated, and sparsely tuberculated; the hand has three distinctly tuberculated carinæ, the lower of which runs along the immoveable finger. The abdomen is about half as broad again in the female as in the

male; the segments are all separate; an obtuse carina extends as far as the middle of the seventh segment, and each of the segments from the second to the fifth has a small tubercle in the centre, and a still smaller one on each side; the sixth segment is nearly square, and the seventh semioval.

Length of carapace, 1·4 inch; breadth, 1·2 inch.

Common in the Gault at Folkestone, Maidstone, &c., and still more so in the upper Greensand at Cambridge.

Obs. This species was first noticed by Mantell, who obtained it at Ringmer, in Sussex, and announced it first in the 'Geology of Sussex,' and afterwards in the 'Geology of the South-East Coast of England.' He subsequently described it, under the name of *Corystes Stokesii*, in the 'Medals of Creation,' in the year 1844. Professor M'Coy, in 1849, made it the type of his genus *Notopocorystes*, and gave a tolerably full description of it, as *N. Mantelli*, expressing at the same time his suspicion that it may be identical with Mantell's species.

It occurs very commonly in the Gault at Folkestone, and in innumerable quantities in the upper Greensand at Cambridge. There are numerous specimens from both these localities in every collection which contains fossils from these prolific beds.

Palæocorystes Normani, *mihi*. Plate III, figs. 10—12.

Testâ ovatâ, valde convexâ, regione cardiacâ tuberculis tribus in serie longitudinali; regione gastricâ in media lævi, ad latera utrinque tuberculis quatuor minoribus.

Descr. Carapace ovate, one fifth longer than it is broad, very convex, the height from the plane of the lowest part of the lateral margin to the highest point of the carapace being two fifths of the transverse diameter; the margins almost evenly rounded; the orbits and frontal region somewhat advanced, narrow, and truncate; latero-anterior margin with three small teeth, latero-posterior margin granulated; the surface of the carapace glabrous, excepting the posterior portion, which is slightly granulated; tubercles few, three or four small ones on the lateral portion of the gastric region, and three on the median line on the cardiac; orbits approximate, with two conspicuous fissures in the upper margin, and a small tooth at the outer angle.

Length of carapace, 1·4 inch; breadth, 1 inch; height, from the plane of the lateral margin, 0·4 inch.

A single specimen only has come under my observation; it is from the Chalk Marl of Ventnor, in the Isle of Wight, and in Mr. Norman's collection, to whom I gladly take the opportunity of recording my obligations, for kindly placing his specimens at my disposal, by dedicating this species to him.

Obs. The distinctions between this and all the other species of the genus are well marked. In the number of tubercles on the carapace it is intermediate between *P. Broderipii* and *P. Stokesii*, having much fewer than the latter species. It is much more convex, the margin is more rounded than in either of the others, and the latero-posterior margin, instead of passing backwards to its junction with the posterior in almost a straight line, as in *P. Stokesii*, is gradually and evenly curved.

Genus—EUCORYSTES, *Bell.*

Char. Gen. *Testa* trapezoidea, depressa, dimidio anteriore sculpto in elevationibus contortis, linearibus, sulcis separatis; dimidio posteriore lævi, granulato; fronte lato. *Orbitæ* magnæ, latæ, margine elevato, usque ad angulos antico-laterales tendentes, suprà bifissæ, infrà unifissæ.

Species unica. EUCORYSTES CARTERI, sp., *M'Coy.* Plate II, figs. 14—17.

Descr. Carapace depressed, somewhat trapeziform, nearly as broad as it is long, not greatly narrowed either anteriorly or posteriorly; the anterior half curiously sculptured, the surface being divided by numerous, variously formed, nearly linear, flattened ridges, which are separated by sulci of about equal width. These ridges are minutely granulated, with a line of somewhat larger granules on their margin, some of which are insulated. The elevations are not, as Professor M'Coy would intimate, absolutely identical with the different regions or lobes of the regions, although they in some measure indicate them, and the metagastric lobe, in particular, forms a dagger-shaped elevation, of which the anterior process, extending forwards to the front, represents the blade; the other ridges are in pairs, excepting a broad median one on the urogastric lobe, extending far to each side, and they are all symmetrical; the posterior half of the carapace is slightly granulated; the latero-anterior margin has two obtuse processes besides the external angle of the orbit; the latero-posterior margin is nearly straight, and the posterior very broad, with the angles rounded. The rostrum is tridentate, the lateral teeth being longer than the central. The orbits are transverse, excessively large, each occupying about a third of the anterior margin of the carapace, and extending to the external angle, where there is a small, blunt tooth; they are about half as broad as they are long, oval, directed forwards, slightly contracted in the middle, and apparently open to the antennary fossæ; their margins are raised, simple, and there are two fissures on the upper, and one near the inner angle in the lower; the front occupies the middle third of the anterior margin of the carapace.

Length of carapace, 1·2 inch; breadth, 1 inch.

Found hitherto only in the upper Greensand of Cambridge.

Obs. A certain general resemblance to some of the species of *Palæocorystes* led Professor M'Coy to consider this species as belonging to that genus, which is identical with his *Notopocorystes.* Hitherto there has been no attempt to separate it from that genus. The several forms of the carapace certainly bear a not very remote resemblance to *P. Broderipii;* but, as it appears to me, the relation is only superficial and on closer examination the form and character of the carapace itself are essentially different, whilst in the far more important points, the structure and form of the orbit and of the frontal region, the diversity is so great as not to admit of any doubt as to their generic distinction. The following are the discrepancies to which I have referred. The carapace in the present species is much more square, the anterior and posterior portions being considerably less narrowed than in any of the species of *Palæocorystes;* the sculpture of the anterior half of the carapace is totally unlike any other species, not only of *Palæocorystes,* but of every other Crustacean form with which I am acquainted, with the exception of *Eumorphocorystes sculptus* of Count von Binkhorst, to which I shall again refer. But when we examine the orbital and frontal regions, which are of so much more importance as generic characters, the discrepancy is still more striking. The breadth of the front between the orbits, equalling the long diameter of each orbit, and especially the enormous size of these cavities, extending to the antero-external angle of the carapace, at once remove the species from a genus in which the front is of moderate size, and the comparatively small and round orbits do not even approach the external angle.

It is certainly remarkable that the peculiar sculpture of the carapace should also occur in a Continental species, to which I have just referred, and to which the excellent palæontologist above named has assigned a distinct generic position. The form and general character of *Eumorphocorystes* are, however, not only essentially distinct from the species now under consideration, but approximate it still more to *Palæocorystes,* although I consider Count von Binkhorst quite justified in the separation he has made.

Professor M'Coy alludes to the comparative rarity of this species. I believe it has hitherto been found only in the upper Greensand of Cambridge, and it was, with great propriety, dedicated to the gentleman in whose fine collection of the fossils of that locality the specimen occurred from which the first description was taken.

Family—CORYSTIDÆ?

Genus—Necrocarcinus.

Char. Gen. *Testa* suborbicularis, rostro triangulari, regionibus distinctis, tuberculis magnis instructis, margine latero-anteriore utrinque producto. *Orbitæ* rotundæ supernè apertæ, supra bifissæ. *Apertura oris* æquè longa ac lata, lateribus concavis.

In the 'Mémoires de la Soc. Lin. de Normandie,' of the date 1836, there occurs a description, by M. Deslongchamps, of a Crustacean from our Gault and Greensand, with the name *Orithyia La Bechei*, and in several of the late Dr. Mantell's works * are notices of the same species from the Gault, which was considered by Dr. Leach, to whom Mantell referred it, as belonging to the Leucoriadæ, and as nearly allied to the recent genus *Arcania*. How our great carcinologist could have arrived at a conclusion so utterly without foundation is more surprising than that Dr. Mantell should have unhesitatingly adopted this hasty view, and published the species with the name *Arcania Bucklandii*. A careful examination of numerous specimens in my own collection, in that of Dr. Bowerbank, and in the British Museum, has not only satisfied me that such is not its true relation, but has led me rather to the opinion, not, however, without some doubt, that it belongs to the Corystidæ, to which family several other species found in the Gault of Folkestone and in the upper Greensand of Cambridge are undoubtedly to be referred. Having carefully compared the specimens of the present genus from Folkestone with those from Cambridge, I find that, notwithstanding their different aspect, they are all of the same species, and identical with the so-called *Arcania Bucklandii* of Mantell; and I have had the satisfaction to find two other species of the same generic form obtained from the upper Greensand of Warminster and Maiden Bradley, in Wiltshire. On searching further, I discovered in a collection of fossil Crustacea from the Isle of Wight belonging to Mr. Norman, of Ventnor, a large specimen of one of these species from the Chalk Marl capping the firestone at Atherfield; and I have since received from Mr. Cunnington, of Devizes, several specimens of the same species from the upper Greensand of Wiltshire. Several species of this genus have been found on the Continent, and I am informed by M. Adolphe Milne Edwards that a Prussian naturalist has given to one of them the generic name of *Necrocarcinus*, which I have adopted, although hitherto I have failed to obtain any clue to the place of its publication.

* 'Med. of Creat.,' p. 534; 'Geol. Suss.,' t. xxix, figs. 7, 8, 14; 'S.E. of Engl.,' p. 159, fig. 3.

NECROCARCINUS BECHEI, sp., *Deslongchamps.* Plate IV, figs. 4—8.

Testâ suborbiculari, modicè convexâ, tuberculis quindecem instructâ, rostro inermo.

ORITHYIA BECHEI, *Deslongch.* (1836). Mem. Soc. Lin. Norm., v, p. 40, t. i, figs. 7—9.
ARCANIA BUCKLANDII, *Mantell* (1844). Med. Cr., p. 534; Geol. Suss., t. xxix, figs. 7, 8, 14; S.E. Eng., p. 159, fig. 3.
NOTOPOCORYSTES BECHEI, *Morris.* Cat., p. 111.

Descr. The carapace in this species is of equal length and breadth, moderately convex, the height from the plane of the lateral margin being not more than one fourth of the diameter; the nuchal furrow deep and broad; the rostrum triangular, hollowed in the centre, and without teeth at the sides; the regions and lobes raised; there are, in all, fifteen large tubercles on the carapace, besides a few small ones on the latero-anterior margin, and an obsolete one immediately behind the rostrum; of these there are two on each protogastric lobe, one on the metagastric, one on the urogastric, one on the cardiac region, one on each epibranchial lobe, one on each mesobranchial, and two on each metabranchial. The posterior margin is hollowed, and immediately anterior to its raised edge is a rather deep depression. The orbits are nearly round, and there are two distinct fissures on the upper margin, with a small tooth between them. The oral aperture is about as broad as it is long, with the edges slightly curved.

Of this species I have never seen the footjaws, the abdomen, or the legs, nor even any portion of these parts, excepting a hand, figured in Plate V, fig. 3, which indicates a minutely granulated surface and a short, rounded, and robust form; the moveable finger bent down to meet the other, which is merely a small pointed process.

Obs. This species is not at all unfrequent in the Gault of Folkestone and in the upper Greensand in the neighbourhood of Cambridge, but I have not seen it from any other locality. The specimens from the two beds above named differ considerably in colour and surface, those from the Greensand being generally much more injured, both from abrasion and fracture, than the others. I have also observed that the single small tubercle at the base of the rostrum is ordinarily more conspicuous in the Cambridge than in the Folkestone specimens, being in the latter often scarcely discernible. These circumstances, however, are not sufficient to constitute specific distinctions.

NECROCARCINUS WOODWARDII, *Bell.* Plate IV, figs. 1—3.

Testâ orbiculari, subglobosâ, tuberculis circa viginti instructâ, rostro utrinque ad basin minutè unidentato.

Descr. The carapace in the present species is nearly orbicular; it is much more elevated than in the former, and in the young state nearly semiglobose; the regions separately are

rather less raised from the general surface, but the tubercles are somewhat more prominent, and in the young state acute at the apex. The rostrum is acutely triangular, longer than broad, and armed on each side at its base with a very small tooth. The tubercles are more numerous than in *N. Bechei*, being not fewer than twenty; the five additional ones are as follows:—the single one behind the rostrum, which in the former is obsolete, is here conspicuous; there is one on each side of the metagastric lobe in addition to the mesial one, and one on each hepatic region. The tubercles are mostly arranged in right lines; thus, besides those on the median line, the seven anterior ones form a perfectly straight line across the anterior part of the carapace, and there is an equally regular longitudinal series on each side. The middle portion of the nuchal furrow does not extend so far backwards as in the former species; the edge of the posterior margin is less raised, and the hollow immediately anterior to it not so deep. The orbits are round, as in *A. Bechei*, but the fissures are less marked, and there is no tooth between them.

Amongst the specimens in the British Museum and in Mr. Cunnington's collection there are several fragments of limbs which I can scarcely doubt belong to this species. Figs. 4 and 5 of Plate V represent the hand and arm probably belonging to the same individual. These are covered with tubercles; the hand is as broad as it is long, the finger short and stout; the arm about twice as long as it is broad. I am confirmed in the opinion that these belong to *Necrocarcinus* by the figure of the hand of *N. inflatus*, which I have received through the kindness of M. Adolphe Milne Edwards, which has the same general aspect; and they can only appertain to the present species. I conclude also that figs. 6 and 7 represent fragments of some of the ambulatory legs.

Length and breadth of the carapace in the largest specimen observed, 2 inches.

Obs. All the specimens I have yet seen, with one exception, are from the Upper Greensand of Warminster and Maiden Bradley, in Wiltshire, and they are somewhat numerous in the British Museum and in the collection of Mr. Cunnington, of Devizes. The exception to which I have alluded is a very large individual in the collection of Mr. Norman, of Ventnor, from the Chalk Marl capping the firestone at St. Lawrence, in the Isle of Wight. This is by far the largest I have seen, being two inches in diameter, whereas the largest from the other localities is not quite an inch and a half.

I have great pleasure in recording the obligations I am under to Mr. Henry and Mr. Woodward, of the British Museum, for their constant kindness and attention, and the great assistance they have afforded me in the preparation of this work, by dedicating to them the present interesting species.

Necrocarcinus tricarinatus, *mihi*. Plate IV, figs. 9—11.

Testâ depressâ tuberculatâ, carinus tribus, longitudinalibus, quarum una in medio regionis cardiacæ, et altera utrinque in regione branchiali.

Descr. Carapace depressed, suborbicular, granulated, with about sixteen moderate-sized tubercles, the regions not very distinct; the curved sculptured line between the meso- and meta-branchial lobes strongly marked, and resembling impressed letters; a distinct, but not very elevated, carina on the median line, extending the whole length of the gastric region, and interrupting the nuchal furrow, and another carina on each branchial region, extending longitudinally on the middle of the metabranchial lobe, strongly granulated; the margin of the specimen described is much broken, so that we are left to speculate in some measure upon the exact figure of the carapace; but following the line indicated by the portions which remain entire, it appears to be less uniformly rounded than in *Necrocarcinus Woodwardii*. The orbits have two fissures in the superior margin, as in the other species.

Length of the carapace, 1·4 inch; breadth, 1·6 inch.

From the upper Greensand of Cambridge and of Wiltshire; it has also occurred in that of Lyme Regis, in Dorsetshire.

Obs. Specimens of this species occur in Mr. Carter's collection from the Cambridge Greensand and in that of Mr. Cunnington from Wiltshire. But probably the earliest notice of it is to be found in Sir Henry de la Beche's paper on "The Geology of the South Coast of England," in the 'Transactions of the Geological Society,' read as early as 1819. It is there mentioned only as "the back of a singular fossil crab," and as the only one he had seen. There is an unmistakeable figure of it,* although the teeth on the anterior margin are represented as far more prominent and acute than any which I have seen on actual specimens.

The distinctions between this and either of the other species of the genus, whether British or foreign, are very obvious. The depressed carapace, the smaller and fewer tubercles, and the distinct, although low, carina on the median line and on each branchial region, are so striking that it cannot be mistaken even for *N. Woodwardii*, which it approaches more nearly than *N. Bechei*.

ORDER—*ANOMURA*.

Family—HOMOLADÆ.

Genus—HOMOLOPSIS, *Carter*, MS.

Char. Gen. Testa longior quam latior, alta, quadrilatera, tuberculata, regionibus distinctis, branchiali maximâ triangulari. *Orbitæ* approximatæ, subrotundæ, suprà unifissæ; *fossæ antennariæ* ovales, transversæ; *epistoma* fortè pentagonum.

* 'Trans. Geol. Soc.,' 2nd ser., vol. i, pl. iii, fig. 1, p. 42.

Species unica. HOMOLOPSIS EDWARDSII, *mihi*. Plate V, figs. 1, 2.

Descr. Carapace rather longer than it is broad, everywhere granulated; the regions and their lobes very distinct and strongly tuberculated; the gastric region broad, the anterior portion, comprehending the epi-, proto-, and meso-gastric lobes, forming on each side a nearly circular area, furnished with five tubercles, and separated from the metagastric by a well-marked furrow; the metagastric lobe has three tubercles disposed in an equilateral triangle; its anterior process extends to just behind the front; the hepatic region is very small on the upper surface, and has a single tubercle; the lateral portion extends broadly downwards to the pterygostomian process, where it has a strong, obtuse carina; the urogastric is linear, and has a few small, inconspicuous tubercles; the epibranchial lobe is very convex, and has a large, strong, and prominent tubercle standing outwards on the latero-anterior margin of the carapace; the mesobranchial has a single tubercle; the metabranchial lobes very large, roughly granulated, without tubercles, of a somewhat triangular figure, the lateral boundary extending forwards to half the length of the carapace; a very distinct sulcus separates each metabranchial from the anterior branchial lobes and from the gastric region, the two meeting in an angle at a short distance from the posterior margin. The gastric region regularly pentagonal, with a single tubercle. The nuchal furrow distinct and deep. The front is small, with a small tubercle on each side, and its apex incurved to meet the epistome. The orbits nearly round, open beneath, with a triangular fissure above near the external angle, exterior to which is a large, strong spine; the antennary fossæ small, oval; epistome large, irregularly pentagonal, with a strong, transverse carina. The broadest part of the carapace is at the anterior and lateral angle of the metabranchial lobes.

Length of the carapace, 0·10 inch; breadth, 0·9 inch.

From the Gault at Folkestone and the Greensand at Cambridge.

Obs. The affinity of this species to *Homola* was first noticed by Mr. Carter, of Cambridge, who had applied to it in his own cabinet the generic name which I have adopted. It bears a strong general resemblance to the genus *Dromilites*, described in the former part of this monograph; but its relation to the *Dromiadæ* is more apparent than real. Whether it may be considered as in any way osculant between these two families, or as, in some degree, confirmatory of an opinion which I have long entertained, that the distinction between the Dromiadæ and Homoladæ is not borne out by the natural relations of the genera composing the two groups, I must leave with this mere suggestion.

The remarkable breadth of the metabranchial lobes is the character which gives it the greatest *primâ facie* likeness to *Dromilites;* but its essential characters, and in particular the absence of all puncta for the insertion of hairs on the carapace, obviously remove it from that genus.

A beautiful specimen in the Museum of Practical Geology, a mutilated one in the British Museum, both from the Gault at Folkestone, and several in Mr. Carter's collection from the upper Greensand at Cambridge, have formed the basis of the above description; unfortunately, the carapace alone remains in all cases, without a vestige of limbs or of any other organs.

Order—*MACRURA.*

Family—ASTACIDÆ.

Genus—Hoploparia, *M'Coy.*

The generic characters will be found in the first part of this monograph, p. 36.

Additional Observations.

The extent, both in time and space, in which the different species of this genus occur in the deposits of seas of very remote epochs, is deserving of particular remark. In the London Clay two well-marked species have been found, and have been already described in this work; and as low as the Greensand at Lyme Regis the existence of a species was long since made known by the late Mr. George Sowerby. I have now to describe no less than two more from the Gault, besides two or three others found in different beds of Greensand in various localities. The generic characters first seized upon by Professor M'Coy cannot be mistaken, and they are equally appreciable in whatever strata the different species may occur. It would, in fact, be difficult to name a genus, either fossil or recent, of which the characters are more definite, and the different species of which are more clearly demonstrable. It is therefore the more remarkable that, with the immense interposition of the whole Chalk formation, the genus so distinctly marked as belonging to the Greensand and Gault is, as it were, reproduced in the London Clay, under only slight, although definite, specific modifications. This would surely indicate that the physical conditions necessary for the propagation and maintenance of this particular form of macrurous Crustacea existing in that early period when the older members of the cretaceous group were formed, should, after the incalculable interspace occupied by the great Chalk deposit, during which period we have no trace of the genus, have again prevailed, and favoured or permitted its development. How these facts are to be accounted for upon the hypothesis of "selection," or of the gradual transformation or development of species, appears to me inexplicable. Even were we to allow that the species in *each* of the different formations may possibly have resulted from variation of one original form, an opinion utterly at

variance, however, with the fact that they are in every case unmistakeably distinct, surely the reappearance of similar forms, under similar circumstances, at such remote periods, *without any intervening link*, cannot be so explained.

Of this genus, although, up to the present time, two species only had been found belonging to an epoch earlier than that of the London Clay, I have to make known four from the Gault, and the upper and lower Greensand. The various species occurring in all these beds—the London Clay, the Gault at Folkestone, and the Greensand of Lyme Regis, of Wiltshire, and of the Isle of Wight—have so many essential points of structure in common, that their generic relation to each other is indisputable, whilst their specific distinction is not less so; nor are the distinctions between any two species of the periods most remote from each other, of greater value or of a different kind from those of the species found in the same bed; and it is remarkable that the very character upon which M'Coy founded the genus, from species in the London Clay, are essentially identical with those which belong to all the more recently discovered species.

This peculiarity, which suggested to M'Coy the name *Hoploparia*, namely, the extraordinary elongation of the supra-orbitar spine, is conspicuous also in the unusual development of the rostrum, which in *H. longimana* is not less than half as long as the carapace.

Upon the whole, seeing that all the rocks in which these Crustaceans are found are of marine origin, we may conclude that they rather represent the recent genus *Homarus*, to which the common lobster belongs, than *Astacus*, which is essentially a fluviatile genus.

Hoploparia sulcirostris, *mihi*. Plate V, figs. 8—10.

Testâ spinosâ, spinâ supra-orbitali rostrum equante, rostro bicarinato; digito immobili manûs majoris falciformi; abdomine punctato.

Descr. The carapace is nearly cylindrical, the anterior portion armed with several rows of spines directed forwards; a very slight furrow on the median line continued on to the posterior portion; the rostrum very long, with two sharp carinæ, and a deep sulcus between them; the supra-orbitar spine as long as the rostrum, and very slender; the nuchal furrow deep, crossing the middle of the carapace in an even line; the posterior portion of the carapace minutely granulated; the abdomen smooth and polished; the epimeral plates slightly granulated; the exterior flap of the tail rounded, nearly as broad as it is long; the division of the two portions about one third from the extremity, the terminal portion forming nearly a semicircle; the anterior legs not more than twice as long as the carapace, exclusive of the rostrum, the wrist and arm together about as long as the hand; the claws of very unequal size and dissimilar form, although less considerably so than in *H. longimana;* the larger hand about half as broad as it is

long; the inner margin with a row of strong spines, directed forwards, the rest smooth and rounded; the fingers nearly as long as the hand, compressed, strongly tuberculated for half its length towards the extremity; the immoveable finger falcate; the smaller hand very slender, with a strong, rounded ridge on each side; the inner margin with a row of spines as in the larger hand; the fingers slender, linear, and nearly straight.

Length of the carapace 1·5 inch, of the rostrum 0·5 inch, of the legs about 3 inches.

Found in the Gault at Folkestone, from which locality there are several specimens in the British Museum, and in Mr. Carter's collection, as well as in the Woodwardian Museum at Cambridge, there are numerous fragments which appear to belong to this species.

Obs. This species is sufficiently distinguished from the others found in the Gault and Greensand by the remarkable spinous armature of the gastric region and of the inner margin of the hand, and by the falciform construction of the immoveable finger of the larger hand.

HOPLOPARIA LONGIMANA, sp., *Somerby.* Plate VI.

Manibus inequalibus longissimis; alterâ gracili, digitis fere linearibus, manu longioribus; alterâ ovali, digitis curvis, manu brevioribus.

ASTACUS LONGIMANUS, *Sowerby.* Zool. Journ., ii, p. 493, t. xvii.
HOPLOPARIA LONGIMANA, *M'Coy.* Ann. Nat., 1849, p. 176.
— — *Morris.* Cat., p. 109.

Descr. The carapace is somewhat uneven, and everywhere granulated, more coarsely on the gastric region, very minutely on the branchial, without spines or other armature, excepting two tubercles on the hepatic region; the nuchal and branchial furrows conspicuous, but not deep; the rostrum half as long as the carapace, extremely slender and longitudinally sulcate; the supra-orbitar spine nearly as long as the rostrum. The abdomen is smooth, sparsely and minutely punctate, the puncta becoming more frequent and conspicuous on the epimeral plates, which are marked with a shallow, even furrow within the margin; the exterior plate of the tail rounded at the extremity. The anterior pair of legs are of very unequal size and of dissimilar form; the arm is nearly as long as the hand, the wrist about half as long; the claws differ greatly; the larger hand is rather longer than the fingers, of a nearly oval form, obtusely carinated on the outer margin, the fingers curved and armed with strong tubercles on the opposing edges; the smaller hand is slender, shorter than the fingers, which are nearly linear, and furnished with a continuous series of small, sharp, triangular teeth.

Length of the carapace 2 inches; breadth, taking the curve from one margin to the

other, 2·5 inches; height 1 inch; length of rostrum 1·1 inch; length of larger hand 1·2 inch; of fingers of the same 1 inch; length of smaller hand 0·9 inch; of fingers of the same 1·9 inch.

Found in the Greensand at Lyme Regis, and at Atherfield, in the Isle of Wight, from both which localities there are numerous specimens in the British Museum, and in Dr. Bowerbank's collection.

Obs. In 1826 the late Mr. George Sowerby published in the 'Zoological Journal' an account of this species, to which he gave the name of *Astacus longimanus*. The specimens described were received through the late Sir Henry de la Beche from the Greensand of Lyme Regis. Since that time several other specimens have been obtained from the same locality, which have enabled me greatly to enlarge the description of the species. Prof. M'Coy very properly considered it as generically distinct from Astacus, and associated it with two species from the London Clay under the present name.

HOPLOPARIA PUNCTULATA, *mihi*. Plate V, figs. 11—13.

Testâ regionibus valdè distinctis; lobo epigastrico granuloso, scabriusculo; protogastrico fortè bituberculato; abdomine minutè punctato.

Descr. There are in the British Museum and in Dr. Bowerbank's collection, several specimens of a species of *Hoploparia* nearly allied to *H. longimana*, but possessing characters which, on very careful consideration, and after some hesitation, I have considered sufficient to determine its specific distinction. It agrees with that species in the general character of the surface of the legs and of the posterior portion of the carapace, as well as in the smoothness of the abdomen and in the important character of its punctate surface; but it differs considerably in the more scabrous surface of the anterior part of the carapace, in the much more distinct demarcation of the regions, in their greater comparative shortness, and in the existence of two very prominent tubercles on the protogastric lobe, which in *H. longimana* are replaced by a small carina; the hands, also, are more nearly of a size, shorter in proportion, and more rounded. This view of the distinctness of the species is strengthened by the fact of its having been found exclusively in the Gault, whilst the true *H. longimana* is found only in the Greensand of Lyme Regis and of Atherfield.

HOPLOPARIA GRANULOSA, *mihi*. Plate VII, figs. 1, 2.

Testâ cylindraceâ, omnino granulatâ, scabriusculâ, sulco lineari continuo a rostro usque ad marginem posteriorem testæ.

In Mr. Cunnington's collection is a specimen consisting of a tolerably entire carapace, wanting, however, the rostrum and the anterior margin, and of three segments of the abdomen; there are also fragments of the anterior pair of legs, evidently belonging to the same individual, consisting of the arm and wrist, both imperfect. These materials are sufficient to indicate the genus, and to distinguish the species from all others.

The carapace is nearly cylindrical and evenly rounded, excepting that the sides are very slightly compressed. The whole surface is granulated, the anterior portion more coarsely, and almost scabrous, and the prominent granulations are directed somewhat forwards; there are indications of two converging carinæ passing to the rostrum, and of a smaller one on each side, as in *H. sulcirostris* and *H. Saxbyi*, and there is a spine at the base of the supra-orbitar process; the carapace is divided through its whole length by a thin, linear sulcus. The abdomen is cylindrical and granulated; the epimeral plates mucronate in the middle of the margin, the second very broad. The anterior legs are somewhat unequal, but less so than in *H. longimana* and some other species. The wrist is long, much compressed, and has four large tubercles at the distal margin.

Length of the carapace 2·1 inches; height 1·2 inch; measurement over the back, from one lateral margin to the other, 2·7 inches.

Obs. This fine species from the Greensand of Wiltshire has the almost circular carapace and abdomen which characterise the genus, the same even direction of the nuchal furrow, and the same peculiar form of the lambdoid furrow. The granular surface of the carapace, becoming almost scabrous at the anterior portion, and an obvious tendency to carination at that part, are equally characteristic of this numerous and widely extended genus, and are quite sufficient, notwithstanding the absence of the rostrum and of the supra-orbitar spine in all the specimens observed, to justify the position I have assigned to this species. It has hitherto only been found in the locality mentioned, and exists, I believe exclusively in Mr. Cunnington's collection.

HOPLOPARIA SCABRA, *mihi*. Plate VII, figs. 3—7.

Testâ maximâ, latâ, regionis branchialis parte posteriore granulis magnis, distinctis, elevatis scabrâ; parte anteriore ejusdem et regione gastricâ tuberculatis. [Brachio triquetro, carinis tuberculato-spinosis (?).]

Descr. The carapace is remarkably large, indicating an animal nearly twice the size of the majority of the species of the genus. The gastric region and the anterior part of the branchial are tuberculated, as is also the median line of the carapace; in the latter the tubercles are in two irregular rows, and almost spiniform; the broad metabranchial lobe is covered with large, regular granulations, which are sufficiently prominent to render the

surface somewhat scabrous; the nuchal furrow is open, but not deep. There is in the British Museum a specimen of an anterior leg (fig. 7), which, from a comparison with the fragment connected with the carapace (fig. 4), I am induced to consider as belonging to this species, although with some degree of doubt. It is of moderate length, the arm about as long as the hand and wrist together, or half as long again as the hand; it is of a triquetrous figure, and each angle is armed with irregular double or triple rows of tubercles; the wrist has several smaller ones; it is about half as long as the hand, or one third that of the arm; the hand, about twice as long as it is broad, has three or four strong spines at its proximal extremity; the outer side is smooth, the inner tuberculated; the fingers are wanting in the only specimen of this part I have seen, which evidently belonged to an individual of comparatively small size.

Length of the carapace about 4 inches, breadth 2 inches.

Found in the Gault at Folkestone, and in the upper Greensand of Cambridge and Wiltshire. There are three specimens in the British Museum from the former locality, two of the imperfect carapace, the third of the anterior leg above described, and there are numerous specimens from Cambridge in Mr. Carter's collection, and one in Mr. Cunnington's, from Wiltshire.

Obs. This is by far the largest species of the genus, if we may judge by the length and breadth of the carapace. Notwithstanding the fragmentary state of the specimens at present known—the whole of the anterior part of the carapace and the abdomen being absent—the form of the nuchal furrow and the general character of the carapace and of the leg clearly fix the genus to which the species belongs.

HOPLOPARIA SAXBYI, *M'Coy*. Plate VIII.

Testâ granulosâ, regione gastricâ scabrâ; carinis quatuor leviter tuberculatis, quarum utrinque una super marginem rostri producta; rostro late sulcato; manibus inequalibus, valde compressis, tuberculatis.

HOPLOPARIA SAXBYI, *M'Coy*. Ann. Nat. Hist., 1854; Cont. Brit. Pal., p. 266 cum fig.

Descr. Carapace semicylindrical, roughly granulated, the anterior portion tuberculated and scabrous; there are two pairs of slightly tuberculated, converging carinæ, the inner two extending to the margins of the rostrum, becoming more elevated forwards, so as to produce a broad and deep sulcus through its entire length; a slight elevation arises from the posterior part of the hollow; the supra-orbital ridges are large and prominent, armed with a strong spine, and terminating in a long, slender, supra-orbital process; the

nuchal furrow strongly marked, and its lateral portion extending further forwards than in most of the species. Abdominal segments more finely and evenly granulated than the carapace. Professor M'Coy states that "the last segment and middle tail-flap have a much coarser, flattened, or squamous tuberculation; the transverse suture of the outer tail-flap strongly marked, from the great thickness of the basal portion;" of this I am unable to speak from my own observation, as in all the specimens I have seen these parts are wanting or imperfect. The anterior legs are very unequal, almost as much so as in *H. longimana.* The arm is tuberculated, with a row of a few large tubercles on the upper side; it is much widened towards the distal extremity, where it is about half as broad as it is long; both the hands are very much flattened, the larger twice as long as it is broad, tuberculated, and armed with a row of large tubercles along the inner edge; the fingers about as long as the hand, the immoveable finger almost falcate, depressed in the middle throughout its length; the prehensile margin strongly tuberculated; the immoveable finger broad and curved, but less so than the other, and armed with similar tubercles. The smaller hand roughly granulated, the inner edge with a series of tubercles as in the larger; the fingers twice as long as the hand, very slender, the immoveable one much flattened and slightly curved; the moveable one less flattened, smaller, and also slightly curved.

Length of the whole body 6·5 inches; length of the carapace, from the margin of the orbit, 2·5 inches; breadth 1·6 inch; length of rostrum 0·9 inch; length of larger hand and fingers 4·2 inches; breadth 1·5 inch; length of smaller hand, with the fingers, 5·2 inches, the fingers occupying more than two thirds of the length.

From the upper Greensand in the Isle of Wight, and near Devizes, in Wiltshire.

Obs. This fine species was first discovered by Mr. Saxby, in the upper Greensand at Bonchurch, in the Isle of Wight, and described in the 'Annals of Natural History' by Mr. M'Coy, who dedicated it to the discoverer. The large specimen figured in Plate VIII is in Mr. Cunnington's collection, and is from the Greensand of Wiltshire; and the hands represented in the same plate belong to another fine example, collected by Mr. Norman, of Ventnor, and now in the British Museum. With the exception of *H. scabra,* it is the largest species of the genus with which we are yet acquainted.

Genus—Astacodes, *Bell.*

Astacodes falcifer, sp., *Phillips.* Plate IX, figs. 1—6.

Myeria falcifer, *Phill.*

Of this remarkable species scarcely sufficient data exist for a satisfactory description; yet the remains which have come into my hands indicate not merely the specific but the

generic distinction from all other forms hitherto discovered. The examination of a beautiful specimen of the last five segments of the abdomen, with the caudal appendages, formerly in the collection of Mr. Bean, of Scarborough, and now in the British Museum, and of several fragments in the museum at York, for the loan of which I have to acknowledge the courtesy of the council of that institution, has enabled me to arrive at the conclusion above stated. The carapace is large and rounded, everywhere coarsely granulated, the granulations being more rough and less frequent on the anterior portion; the nuchal furrow deep and sloping, bordered on each side by a small, granulated carina, and there are two or three longitudinal carinæ on the sides of the anterior part of the carapace; the abdomen is semi-cylindrical, very even, polished, and conspicuously punctate; the epimeral plates of the fourth, fifth, and sixth segments are prolonged into an elegant falciform process, with the points directed backwards, and the anterior margin of each regularly dentated. The seventh segment or central caudal plate is broad, and furnished with a few tubercles; the lateral caudal plates rather narrow, obsoletely carinated, and fimbriated at the extremity; the common basal point oval; the hand is remarkably robust, coarsely granulated, the fingers armed with strong tubercles on the prehensile edge.

Found in the Speeton Clay.

It appears that Prof. Phillips considers this species as belonging to the genus Meyeria; it does not, however, appear to me that this view is borne out by the structures above mentioned. The peculiar characters of that genus are wanting, and the whole aspect of the portions which have come under my observation is widely different. The even, polished, punctate abdomen, with its falciform lateral processes, and the robust, powerful claw, are utterly unlike those parts in the genus in question.

There is in the British Museum a fragment consisting of three segments of the abdomen of a small macrurous species from the Speeton Clay, formerly in the collection of Mr. Bean, and named by that gentleman *Astacus multicavatus*. The surface is regularly, as it were, eroded by numerous conspicuous, impressed puncta; there is on each side a prominent carina; the epimeral processes are acutely triangular, and turned a little backwards.

There is also a specimen from the same locality of a pair of hands, which probably may have belonged to the same species. They are of equal size and similar form; evenly rounded, somewhat tumid, nearly oval, being contracted at each extremity; the fingers are slender; the surface is minutely but roughly granulated. In both cases the data are too scanty to afford any satisfactory suggestion as to the relation of the species.

The specimens are figured, somewhat enlarged, at Plate IX, figs. 7, 8.

Genus—Meyeria, *M'Coy.*

Char. Gen. *Testa* compressa, alta, pluri-carinata, rostrata; sulco nuchali acutè angulari. *Abdomen* semicylindricum, sculptum, processu laterali segmenti secundi lato, rotundato. *Caudæ flabellum exterius* transversé divisum.

The genus *Meyeria* was established by Prof. M'Coy for the reception of two very beautiful species, one of which is peculiar to the Speeton Clay, the other occurring in great numbers in the lower Greensand of Atherfield, in the Isle of Wight. Its characters are strongly marked, and the general aspect very peculiar. The carapace in each of the species at present known is much compressed, very deep, and sharply and highly ridged along the middle of the back; it is marked with several distinct carinæ, those on the portion anterior to the nuchal furrow (the cephalic arch), most strongly so; the nuchal furrow is deep, and in the form of a V, each half meeting the opposite one on the median line in an acute angle; the sides of the posterior portion (the scapular arch), are very broad and flat; the rostrum is small and acute. The abdomen is in both species curiously but diversely sculptured; the epimeral plates are rather large, that of the second segment broad and rounded, the posterior ones trigonal and slightly curved. The exterior caudal piece is divided at about one third from the extremity by a transverse joint, as in the Astacidæ in general, which is marked by a thin carina. The legs, judging from the fragments which have hitherto been observed, are long and slender; but at present nothing is known as to the form of the terminal joint.

Professor M'Coy placed this genus in the family Thallassinadæ (*Thallassiniens* of Milne Edwards), but, as I shall presently show, upon entirely mistaken grounds. The genus to which he supposes it to be most nearly allied is *Gebia*, a fossorial form, of which two species inhabit our coasts. The characters upon which M'Coy relies for the supposed relation are the size of the abdomen and the compressed form of the carapace. In the first place, however, these characters are by no means universal in the family in question, nor are they absent in several other families. The size of the carapace alone would at once put it out of the category, as in the fossorial group this is invariably small, and generally round; but there are other characters which positively associate it with the Astacidæ. The division across the exterior plate of the tail is an absolutely distinctive character of the latter family, never occurring in the others; the epimeral plates of the abdominal segments are large in the present genus; they do not exist in any of the Thallassinadæ. There can, therefore, be no doubt as to the association of *Meyeria* with the Astacoid group, and it is remarkable that hitherto we are unacquainted with a single Thallassinian form in our British rocks, although several well-marked species have been found on the Continent, and have formed the subject of a very interesting and well-elaborated paper by M. Adolphe Milne Edwards, which evinces a thorough knowledge of his subject, and a discrimination worthy of the distinguished name he bears.

Meyeria ornata, sp., *Phillips*. Plate IX, figs. 9—11.

Segmentis abdominis seriebus quatuor vel quinque transversis granorum ornatis; processibus lateralibus granulatis.

Astacus ornatus, *Phill.* Geol. York, t. iii, fig. 2.
Meyeria ornata, *M'Coy.* Ann. Nat. Hist., 1849, p. 333; Contrib. to Brit. Palæont., p. 138.
— — *Morris.* Cat. Brit. Foss., p. 111.

Descr. Carapace scabrous, with even, sharp granulations; the portion anterior to the nuchal furrow (the cephalic arch) with three or four denticulated carinæ; the nuchal furrow deep, forming an acute angle on the mesial line of the back. The portion behind the furrow (the scapular arch) much larger than the former, compressed, scabrous, with rather distant granulations. The abdomen is semi-cylindrical; each segment ornamented with four or five transverse, elevated rows of very distinct, rounded granulations, and similar ones are scattered over the epimeral plates, which are moderately large, those of the first and second segment broad and imperfectly quadrilateral, the remainder trigonal. The tail is rather short, the central plate rounded at the extremity, sulcated, and granulated; the exterior plate is slightly curved, and has a longitudinal carina and furrow and a row of granulations.

Length of the carapace 1·3 inch, length of abdomen 2 inches.

This species has, I believe, been hitherto found only in the Speeton clay, where it occurs in oval nodules. Specimens exist in the British Museum, in the Woodwardian at Cambridge, the York Museum, and in Dr. Bowerbank's and other private collections.

Meyeria vectensis. Plate X.

Segmentis abdominis longitudinaliter tricarinatis; carinis granulatis.

Myeria magna, *M'Coy.* Ann. Nat. Hist., 1849, p. 334; Contrib. Brit. Palæont., p. 139.
— — *Morris.* Cat. Brit. Foss., p. 111.

Descr. The carapace in this species is very deep, much compressed, the lower part of the sides being nearly perpendicular; the nuchal furrow is deep, and its angle is less acute than in *M. ornata*; the cephalic portion is gradually narrowed forwards, terminated by a short, slender, acute rostrum, which is not more than one fourth the length of the

5

cephalic portion of the carapace; there are on this part seven more or less distinct carinæ, three pairs and one on the median line; the lowest is short, and extends backwards along the side of the scapular arch, being interrupted only by the nuchal furrow; the next above it is strongly marked, acute, and, like the former, has a series of small tubercles; it extends forwards to a minute superorbitar spine; the median carina extends from a short distance in front of the nuchal furrow nearly to the rostrum, and two others, converging regularly, terminate at its apex. The scapular arch or portion of the carapace behind the nuchal furrow has a strongly raised median carina, another on each side continuous with the second on the anterior portion, and between these is an awl-shaped elevation, passing backwards and upwards, and, like the former, tuberculated. The whole surface is granulated, though more sparsely than in *M. ornata.* The abdomen is more compressed than in that species; the segments are somewhat longer, and have three small longitudinal carinæ, each of which is furnished with a series of a few granulations. The lateral or epimeral processes are irregularly sculptured, and have a few scattered granulations. The lateral pieces of the tail have each a longitudinal carina, and the exterior one shows very distinctly the transverse division which denotes its relation to the Astacoid group. The legs are long, slender, and compressed, and the first (?) pair, which is extremely long, is angular and carinated, and has several longitudinal rows of small spines. Judging from the fragments which I have had an opportunity of examining, this extraordinary development of the leg may depend on sex, as the portion which remains of this limb in some specimens appears to be much smaller than in others. The second pair is also much larger than the remaining ones. The latter are nearly smooth, and evenly compressed, without any angularity.

Length of carapace 2·5 inches, height 1·2 inch; length of abdomen 3·5 inches.

From the Greensand at Atherfield, in the Isle of Wight, where it occurs in profusion, so as to have given to the beds where it is found the name of "Lobster beds"—M'Coy also gives "Speeton clay of Speeton" as another locality, but I have not met with any specimens from thence, and am doubtful of the correctness of this statement.

Genus—Phlyctisoma, *Bell.*

Char. Gen. *Testa* tuberculata, lobo mesogastrico distincto, separato, lineari. *Abdomen* semicylindricum, epimeris elongatis, angustis. *Pedes* antici robusti, tumidi, tuberculati; reliqui lævis, compressi.

PHLYCTISOMA TUBERCULATUM, *mihi*. Plate XI, figs. 1—8.

Testâ omnino tuberculatâ.

Descr. The carapace in this remarkable species is semi-cylindrical, covered in every part with tubercles, which are of dissimilar sizes; it is divided longitudinally by a narrow and deep mesial sulcus, which bifurcates at the anterior part of the carapace, to enclose the mesogastric lobe, which is thus completely insulated from the surrounding part of the gastric region; it is almost linear in form, terminating posteriorly in a point at a short distance from the nuchal furrow. The meso-branchial furrow is nearly parallel with the nuchal, and similar to it in breadth and depth; they are both rather deep, smooth, and polished. There is a short, curved, connecting furrow extending between them, near the margin of the carapace, separating the epibranchial lobe, and with the others enclosing the mesobranchial. The cardiac region is faintly indicated, it is of a triangular form, and is divided by the longitudinal mesial furrow; the posterior margin of the carapace is curved forwards, and has a distinct, raised edge, bounded by a deep furrow. The abdomen is semi-cylindrical, the segments somewhat tuberculated; the epimeral processes are long, narrow, and triangular, excepting the second, which is broad and quadrate, and hollowed in the middle. The caudal segment or central plate of the tail is broad, rounded, and curiously marked with sulci, ridges, and tubercles, and the margin is raised. The external caudal plates are wanting in all the specimens observed. The anterior legs are robust, tumid, and covered with tubercles, similar to those of the carapace. Portions of the arm, wrist, and hand are figured in the plate. The portions of ambulatory legs hitherto obtained, show them to be compressed and quite smooth.

All the known specimens, and they are very numerous, are from the Greensand of Cambridge, and are principally in Mr. Carter's fine collection of Crustacea from those beds.

Obs. This genus is in several respects a remarkable one, and presents characters which forbid its being associated with any other. The general aspect of the carapace, its crowded tuberculation, uniform in all its parts in the present species, the breadth and direction of its sulci, give it a *primâ facie* resemblance to *Hoploparia scabra*, but this similarity only holds in unimportant characters, and even in these is more apparent than real. The tubercles are in this species spread over the whole surface, without the mesobranchial area which is so characteristic of *H. scabra*. The sulci also are different in their direction, although similar in depth and in the smoothness of their surface. The most striking peculiarity, however, and that by which it is distinguished from all other genera, recent or fossil, which have come under my notice, is the distinct insulation of the meto-gastric lobe, which is enclosed, as it were, by a bifurcation of the longitudinal mesial furrow. The

form of this separated piece is also altogether different from the element of which it is the homologue in every other genus. Another remarkable peculiarity is in the form of the epimeral plates, which are remarkably long and narrow.

The existence of a cardiac region, which appears to me to be certainly, although faintly, indicated, in conjunction with a median sulcus by which it is longitudinally divided into two portions, forms, if I am right in this appropriation, an exception to the law laid down in the elaborate and learned disquisition on the elements of the carapace by Prof. Milne Edwards,* that when, as in the case of the common lobster, the carapace is divided along its whole length by a median furrow, it is at the expense of the cardiac region. In the case, also, of *Glyphæa*, the whole scapular portion of the carapace is thus divided, yet the cardiac region appears to me to be quite as distinct as in any other macrurous form, and more so than in most.

PHLYCTISOMA GRANULATUM, *mihi*. Plate XI, figs. 9, 10.

Lobis metabranchialibus granulatis, haud tuberculatis.

In Mr. Carter's collection are several fragments of a species distinct from the former, which on close examination I find to possess the remarkable peculiarity upon which I have found it necessary to constitute the present genus, namely, the insulation of the mesogastric lobe, of a linear form, by the bifurcation of the median furrow. In the present species the whole of the broad metabranchial lobe is covered with uniform granulations, instead of the distinct tubercles which cover this as well as every other part of the carapace in *Ph. tuberculatum*. The remaining portion of the carapace in this species is also tuberculated, but less thickly than in the former.

All the fragments which I have seen are too imperfect to allow of any further description, but the generic identity and the specific distinction of the two are equally certain.

It is found with the former in the upper Greensand of Cambridge.

* 'Ann. des S. Nat.,' 1851, p. 247.

Genus—Glyphæa, *Meyer.*

Glyphæa cretacea, *M'Coy.* Plate XI, figs 11—13.

Arcâ cephalicâ testæ politâ, septem-carinatâ ; carinis granulatis.

Glyphæa cretacea, *M'Coy.* Ann. Nat. Hist., 1854, p. 118, pl. iv, fig. 2 ; Contrib. to Brit. Palæont., p. 268, fig. 2.

Descr. The carapace is nearly cylindrical, somewhat narrowed anteriorly ; the cephalic arch nearly as long as the scapular ; the ground surface of this part smooth and polished, having seven distinct carinæ, which are nearly parallel, and each, with the exception of the median one, formed of a single row of granulations ; the hepatic region granulated ; the nuchal furrow extends almost straight across the dorsal part of the carapace, excepting a slight angle forwards on the median line ; the scapular arch divided by a median longitudinal furrow ; the regions distinct ; the cardiac region broad, polished, and sparsely granulated ; the branchial uniformly more closely so, and with the lobes distinctly marked ; the epibranchial small, sending forward a narrow process, which extends to the side of the hepatic region ; the mesobranchial linear, narrow, and oblique ; the metabranchial very broad, and very uniformly covered with granulations. The only portion of the limbs which I have seen consists of the wrist and part of the hand, by which it appears that the former is very small and triangular, the latter remarkably long, slightly granulated, somewhat compressed, and having a very shallow, longitudinal groove near the lower margin.

Length of carapace 1·2 inch.

It has hitherto occurred only in the Greensand at Cambridge, and all the specimens I have seen are in Mr. Carter's collection.

Obs. It is very difficult to assign with any certainty to what family of recent Crustacea this genus either belongs or is more nearly related. The absence, in all the remains hitherto found, of any portion of the abdomen, and, indeed, of all those parts upon which naturalists usually depend for the generalisation of the species in Crustacea, precludes any definite opinion on this head. The structure of the scapular arch is perfectly consistent with its being an Astacoid form ; but the cephalic portion of the carapace is quite distinct from any other known genus. Professor M'Coy very truly observes that there is no "possible modification of Milne Edwards' nomenclature of the parts of Crustacea which would enable us to describe the ridges and sulci of the gastric* region of a Glyphæa in terms indicating any homology with corresponding parts in other Decapoda."

* Mr. M'Coy's word is *branchial ;* doubtless a slip of the pen.

This genus was first determined by Meyer. Three, if not four, species have been found in Britain, of which the present, and probably a new one, only belong to the cretaceous beds.

There are in Mr. Carter's collection of the Cambridge Greensand Crustacea two fragments of the carapace, which certainly appear to belong to a species of this genus, which differs from *G. cretacea* in having that portion of the carapace anterior to the nuchal furrow granulated as well as the branchial regions, instead of being polished, and the longitudinal ridges are similar in character. The fragments are too imperfect to form the subject of a satisfactory description. I propose to give it provisionally the name of *Glyphæa Carteri.* It is figured in Plate XI, fig. 14.

ADDENDA.

Etyus similis, *mihi*. Plate I, fig. 12; and XI, fig. 15.

At page 6 I referred to a supposed variety of *Etyus Martini*, of which also a figure, representing the orbits, is given in Plate I, fig. 12. The examination of two additional specimens with which I have been favoured by Mr. Carter, has, however, convinced me that these, with the former, belong to a distinct species, to which, from its great similarity to *E. Martini*, I have given the above name.

The ground of the carapace is more minutely granulated than in the former species. The tuberculation is considerably different, the whole portion anterior to the nuchal furrow being studded, somewhat irregularly, with distinct tubercles. The nuchal furrow is more waved in its course across the carapace, and it is deeper and broader; the regions generally are more elevated; the teeth of the latero-anterior margin are more regular and prominent, but without the distinct terminal tubercle which exists on each of the slight lateral projections in the former. All the specimens examined were imperfect at the posterior portion of the carapace, but it appears, from the proportions of the regions generally, that this species is somewhat broader in proportion to its length.

It occurs with the other species in the Cambridge Upper Greensand.

Eucorystes Carteri, *var*. Plate XI, fig. 16.

Mr. Carter has favoured me with the opportunity of examining and figuring a very interesting variety of *Eucorystes Carteri*, in which the posterior half of the carapace corresponding with the scapular arch is sculptured in the same manner as the anterior half, as figured in Plate II, figs. 14 and 17. In this, the only existing specimen, there is, in addition to the sculpturing before described, a median longitudinal ridge, and one on each branchial region. These are linear, flattened, and granulated as the others. Whether this may be considered as the normal condition of the species or not it is difficult to determine,

but I have thought that in one or two specimens of the ordinary form I have detected a trace of the posterior median ridge.

The approximation of this genus to *Eumorphocorystes* of M. Binkhorst is apparently strengthened by the occurrence of this specimen.

In Mr. Carter's rich collection of Crustacea from the Cambridge Greensand, to which I have been so largely indebted, are numerous specimens of fragments of limbs of the greatest interest and beauty. I cannot but hope that before this work is completed fresh investigations may enable us to appropriate some of these to species yet to be described, and in this hope I have refrained from figuring or further alluding to them.

PLATE I.

Fig.

1. *Trachynotus sulcatus* (p. 2), from the Upper Greensand of Wiltshire. In Mr. Cunnington's collection.

2, 3. *Mithracites vectensis* (p. 1), from the Lower Greensand in the Isle of Wight. The former in the British Museum, the latter in Dr. Bowerbank's collection.

4—6. Three views of *Xanthosia gibbosa* (p. 3), from the Greensand of Wiltshire. In the collection of Mr. Cunnington.

7. *Etyus Martini* (p. 5), from the Gault at Folkestone; restored from specimens in the author's collection.

8. Under side of the same, from a specimen from the Greensand of Cambridge.

9. Abdomen, and

10. Footjaw of the same.

11. Hand of the same species, from the Greensand of Cambridge. In Mr. Carter's collection.

12. Front view of *Etyus similis* (p. 6 and 39), see Pl. XI, fig. 15.

13. *Xanthosia granulosa* (p. 4), from the Greensand of Cambridge. In Mr. Carter's collection.

14. *Diaulax Carteriana* (p. 6), from the Greensand of Cambridge. In Mr. Carter's collection.

15. Front view of the same, shewing the orbits.

16. Hand of the same.

17. *Cyphonotus incertus* (p. 8), from the Greensand of Wiltshire. In the collection of Mr. Cunnington.

18. Front view of the same specimen.

19. A larger individual from the Cambridge Greensand. In Mr. Carter's collection.

Figs. 1, 7, 8, 14—18, are enlarged by one third.

Plate I.

Jos Dinkel lith

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PLATE II.

Fig.

1—3. Back, front, and side views of *Plagiophthalmus oviformis* (p. 9), from the Greensand of Wiltshire. In Mr. Cunnington's collection.

4—6. Back, front, and side views of *Hemioön Cunningtonii* (p. 10), from the Greensand of Wiltshire. In Mr. Cunnington's collection.

7. Under view of a specimen of the same, from the Cambridge Bed. In the author's collection.

8—10. Upper, side, and under views of *Palæocorystes Broderipii* (p. 14), after specimens in Dr. Bowerbank's collection, from the Gault at Folkestone.

11. Specimen showing the anterior pair of legs, from the same locality. In the author's collection.

12. Under side of the same, showing the basal joint of the legs, and part of the footjaws.

13. Diagram of the abdomen, of the same species.

14. *Eucorystes Carteri* (p. 17), from the Greensand of Cambridge. In Mr. Carter's collection.

15. Under side of a small specimen of the same.

16. Front view of the same species, showing the large and distant orbits.

17. Restored view of the carapace of the same species.

Plate II

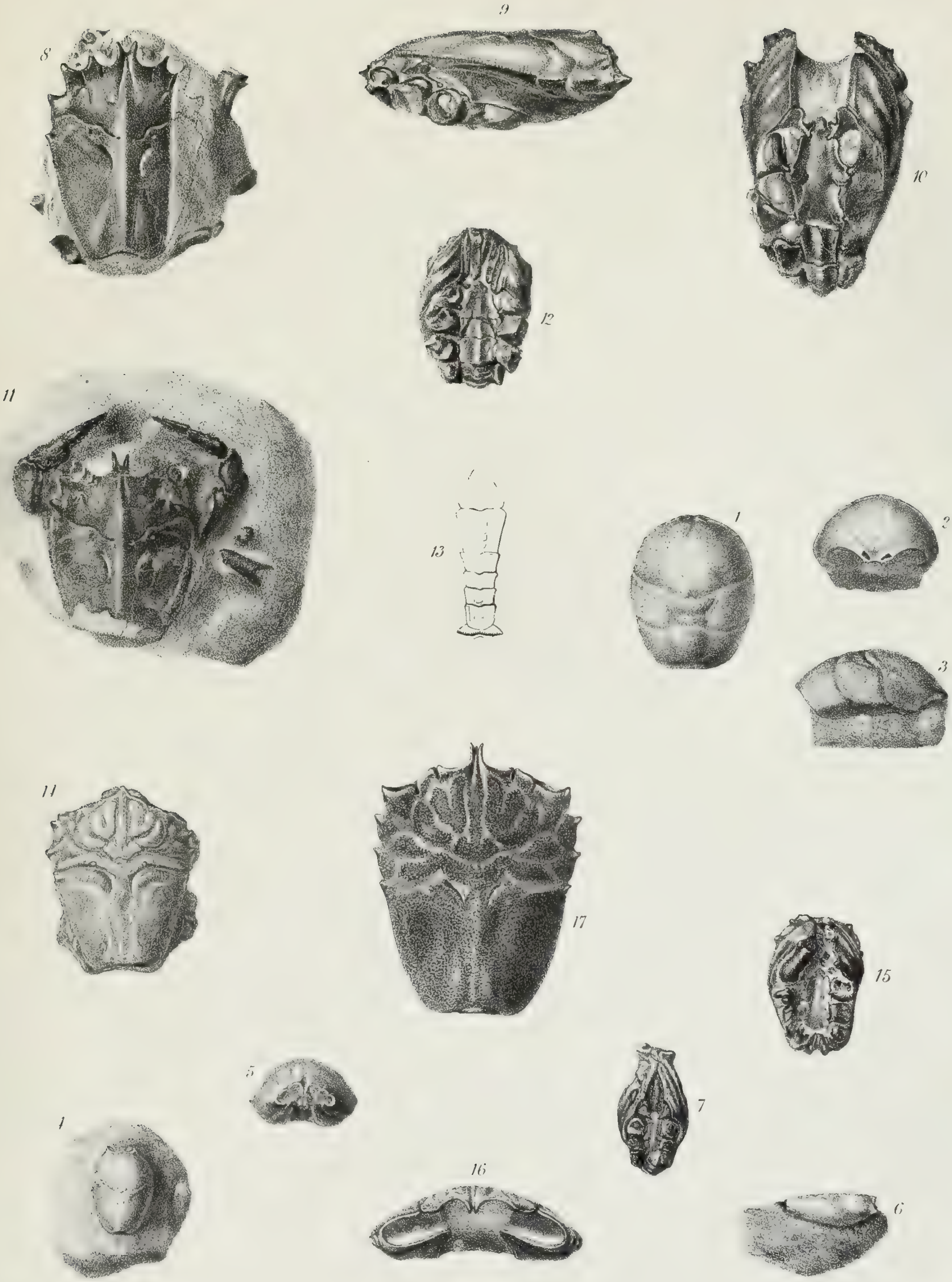

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PLATE III.

Fig.

1. *Palæocorystes Stokesii* (p. 15).
2. The same, showing a portion of the abdomen.
3. Carapace of the same, infested with a bopyriform parasite, from the Cambridge Greensand.
4. The same, with the anterior leg.

5, 6. Specimens showing the basal joints of the legs and the footjaws.

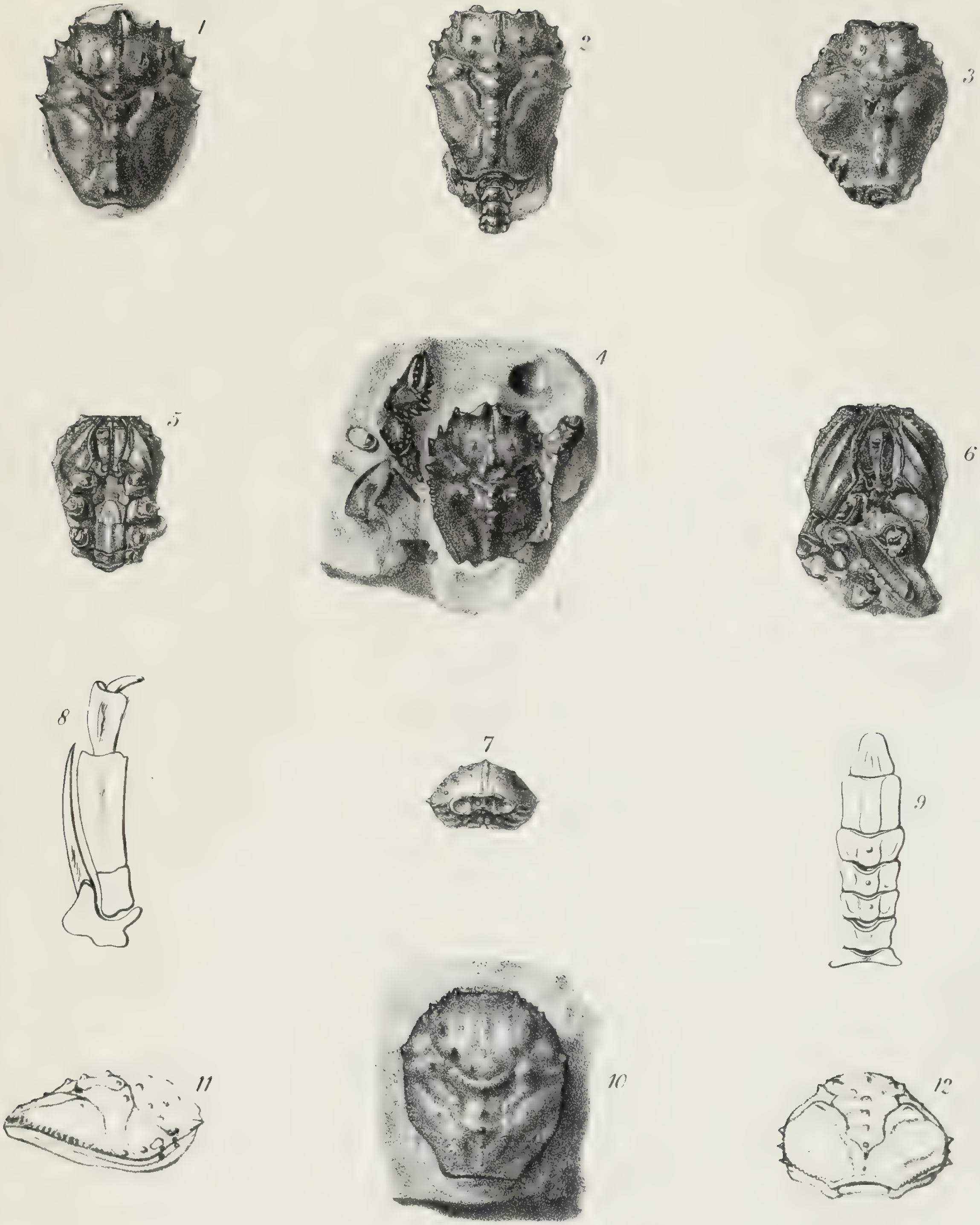
7. Front view of a small specimen of the same species.

8, 9. Diagrams of the abdomen and footjaw.

The specimens are all in the collections of Dr. Bowerbank and the author, and with the exception of fig. 3, are from the Gault, at Folkestone.

10—12. Upper, side, and back views of *Palæocorystes Normani* (p. 16), from "The Chalk Marl, capping the fire-stone," at Ventnor, in the Isle of Wight. In the collection of Mr. Norman, of that place.

Plate III



Jos. Dinkel, del.

W. West, imp

PLATE IV.

Fig.

1. *Necrocarcinus Woodwardii* (p. 20), from a fine specimen in Mr. Norman's collection, from "the Chalk Marl, capping the firestone," at St. Lawrence, in the Isle of Wight.

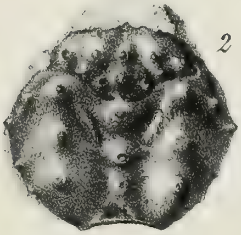
2, 3. Small specimens of the same, from the Greensand of Wiltshire. In the collection of Mr. Cunnington.

4—8. *Necrocarcinus Bechei* (p. 20), after specimens in the collections of Dr. Bowerbank and the author, from the Gault, at Folkestone, and the Greensand of Cambridge.

9. *Necrocarcinus tricarinatus* (p. 21), from Wiltshire. In Mr. Cunnington's collection.

10, 11. Smaller specimens of the same, from Cambridge. In the author's collection.

Plate IV.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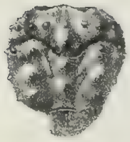
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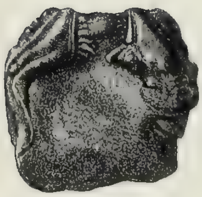
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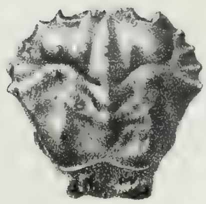
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PLATE V.

Fig.

1, 2. Upper and under side of *Homolopsis Edwardsii* (p. 23), from a fine specimen in the Museum of Practical Geology, from the Gault, at Folkestone.

3. Hand of *Necrocarcinus Bechei*. In the collection of Mr. S. J. Mackie, from the Gault, at Folkestone.

4, 5. Hand and arm of *Necrocarcinus Woodwardii*.

6, 7. Portions of the legs, probably of the same species.

The last four specimens are in Mr. Cunnington's collection, from the Greensand of Wiltshire.

8. *Hoploparia sulcirostris* (p. 25).

9. Anterior portion of the carapace of the same, showing the rostrum.

10. Side view of the abdomen, of the same species.

The specimens are all from the Gault, at Folkestone. In the British Museum.

11-13. *Hoploparia punctulata* (p. 27), from the same locality, and also in the British Museum.

14. Portion of the carapace of an unknown Macrurous Crustacean. In the collection of Mr. Mackie.

Plate V.

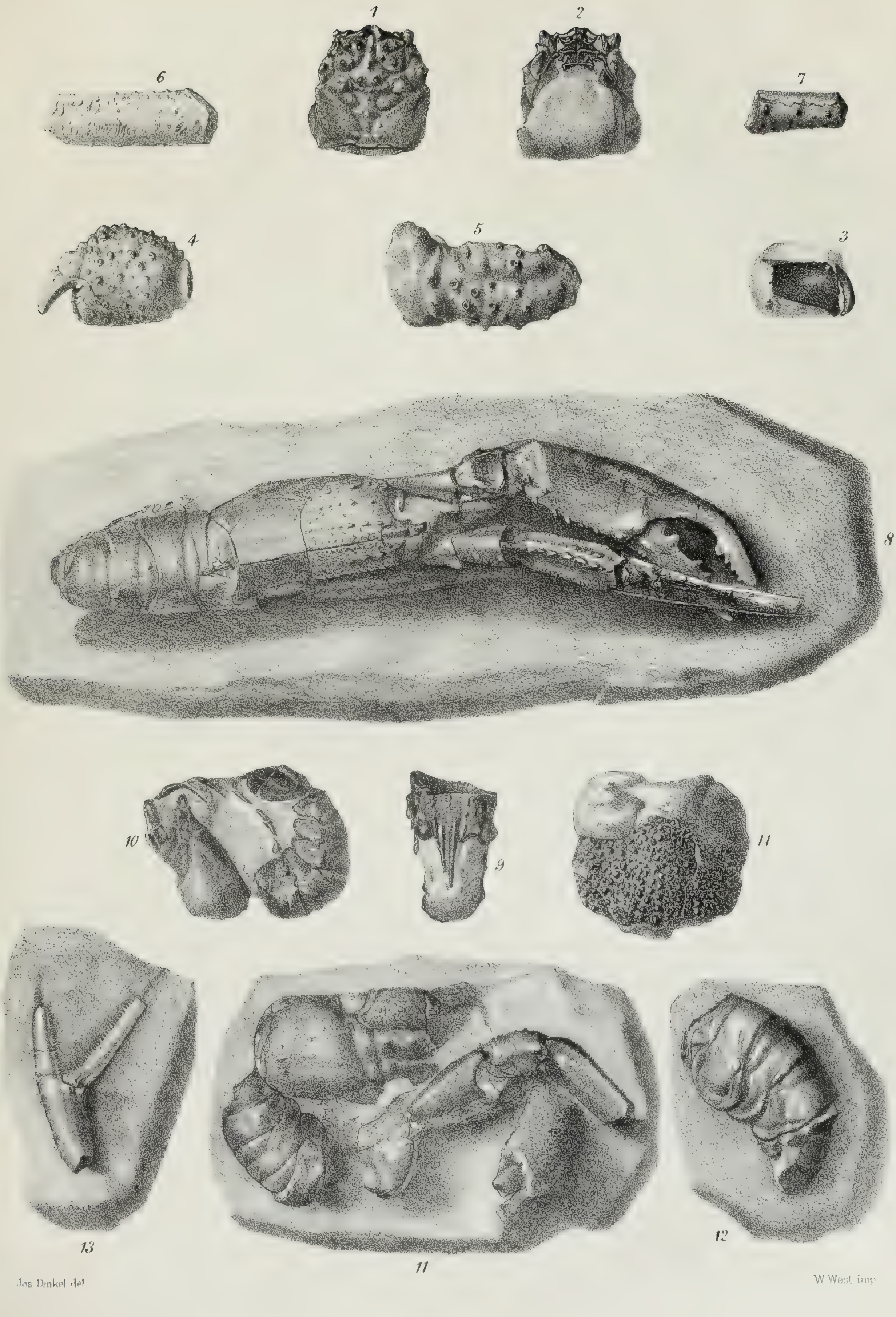

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PLATE VI.

Fig.

1. *Hoploparia longimana* (p. 26), from the Greensand, at Lyme Regis. In the British Museum.
2. Copy of the original engraving of the same species, illustrating Mr. Sowerby's paper in the 'Zoological Journal,' vol. ii, p. 493, pl. xvii.
3. The claws of a remarkably large specimen of the same, from the Greensand, at Atherfield. In Dr. Bowerbank's collection.

1

2

3

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PLATE VII.

Fig.

1, 2. *Hoploparia granulosa* (p. 27), from the Upper Greensand of Wiltshire. In Mr. Cunnington's collection.

3. *Hoploparia scabra* (p. 28). One side of the carapace, showing the posterior granulated scabrous portion, the tuberculated area behind the nuchal furrow, and the tuberculated gastric region. The specimen is from the Gault, at Folkestone, and in the British Museum.

4. Right side of the carapace of the same species, from the same locality, and also in the British Museum.

5. The tuberculated portion of the carapace of the same.

6. Left side of the carapace of the same. This and the last, are from the Cambridge Greensand, and in Mr. Carter's collection.

7. Anterior leg, probably of the same species, from the Gault, at Folkestone. In the British Museum.

Plate VII.

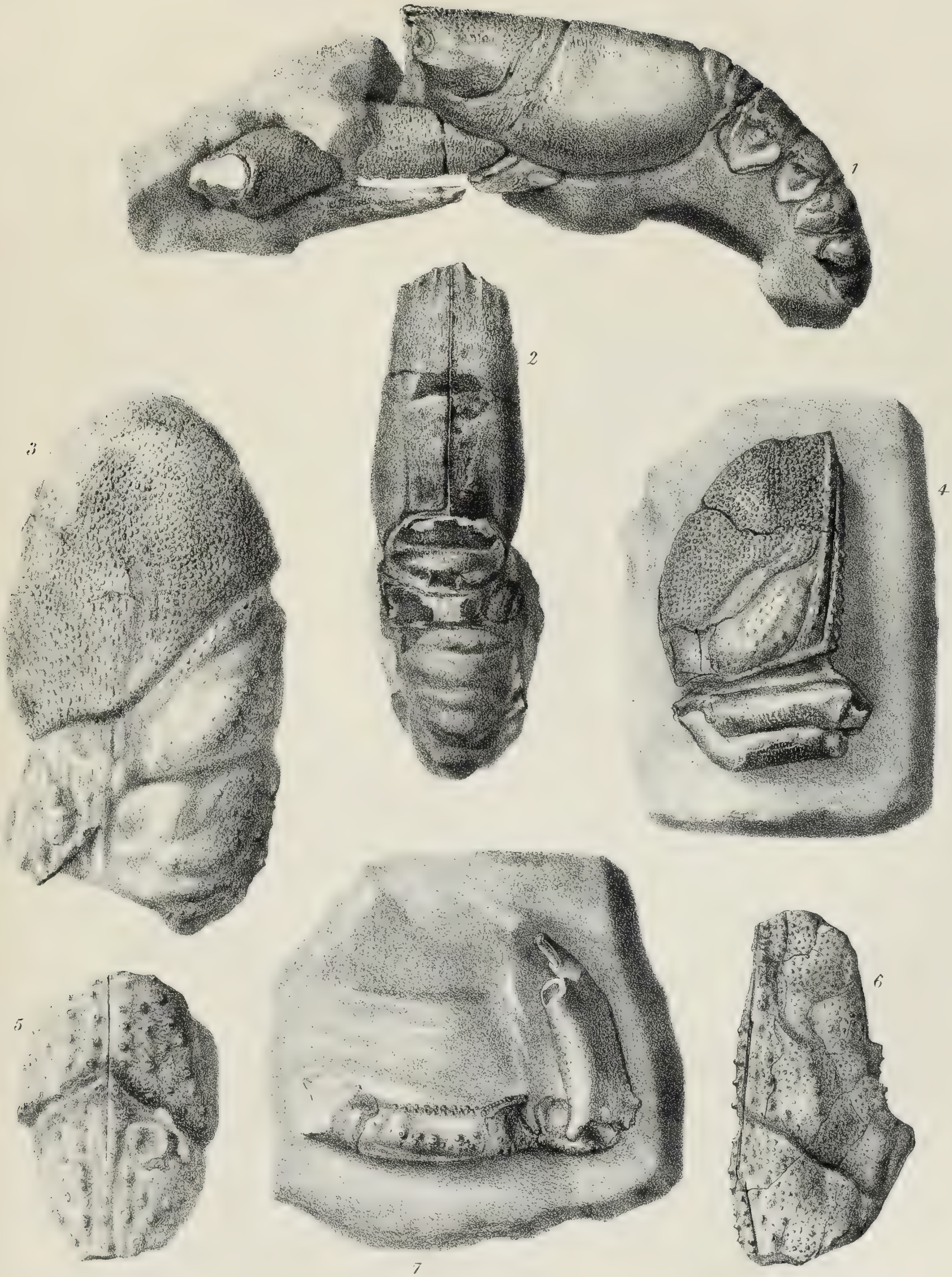

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PLATE VIII.

Fig.

1. Carapace and abdomen of *Hoploparia Saxbyi* (p. 29), from the Greensand of Wiltshire. In Mr. Cunnington's collection.

2, 3. Claws and hands of the same species, from Ventnor. In Mr. Norman's collection.

3

1

2

PLATE IX.

Fig.

1, 2. Abdomen of *Astacodes falcifer* (p. 30), from a specimen in the British Museum, formerly in Mr. Bean's collection.

3–5. Fragments of the carapace of the same. In the museum, at York.

6. A hand, in the same collection, marked, as belonging to this species, which is doubtful from its great size.

7. Portion of the abdomen, and 8, the hands of a species, named by Mr. Bean, "*Astacus multicostatus*" (p. 31). In the British Museum.

9, 10. Carapace and abdomen of *Meyeria ornata* (p. 33). In the museum, at York.

11. Anterior portion of the carapace of the same. In the British Museum.

All the specimens figured in this plate are from the Speeton Clay.

Plate IX.

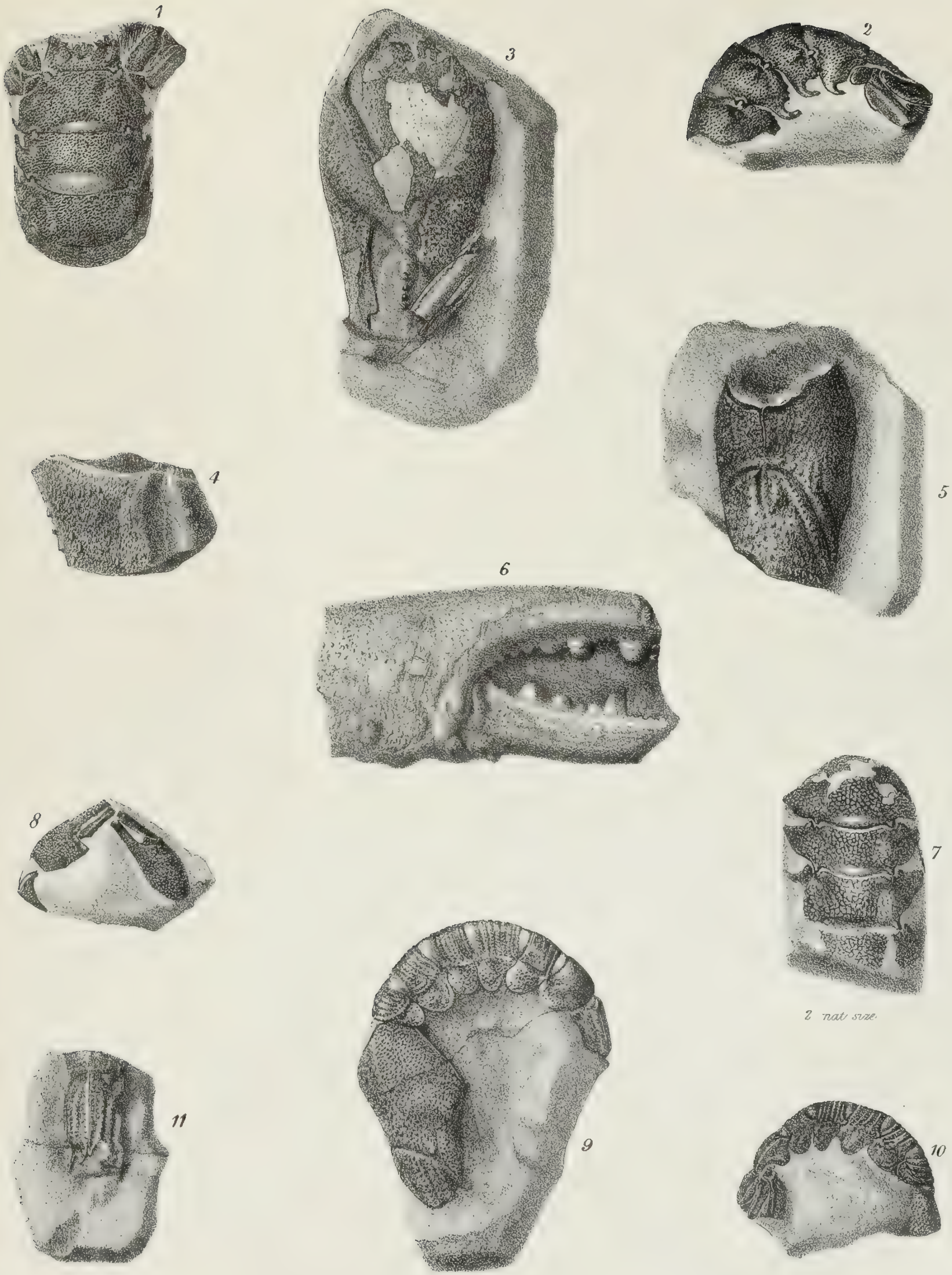

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PLATE X.

Fig.

1. *Meyeria vectensis* (p. 33). After a fine specimen, in Mr. Norman's collection, from Atherfield.
2. The same species, from a specimen in the British Museum, showing, with other interesting details, the transverse articulation of the outer caudal plate, indicating the astacoid relation of the genus.
3. A beautiful example of the carapace of this species.
4. A specimen, showing the structure and great length of the anterior legs.
5. A fragment, with portions of the other legs.

The last three figures are from specimens in Dr. Bowerbank's collection, and are from Atherfield.

Plate X.

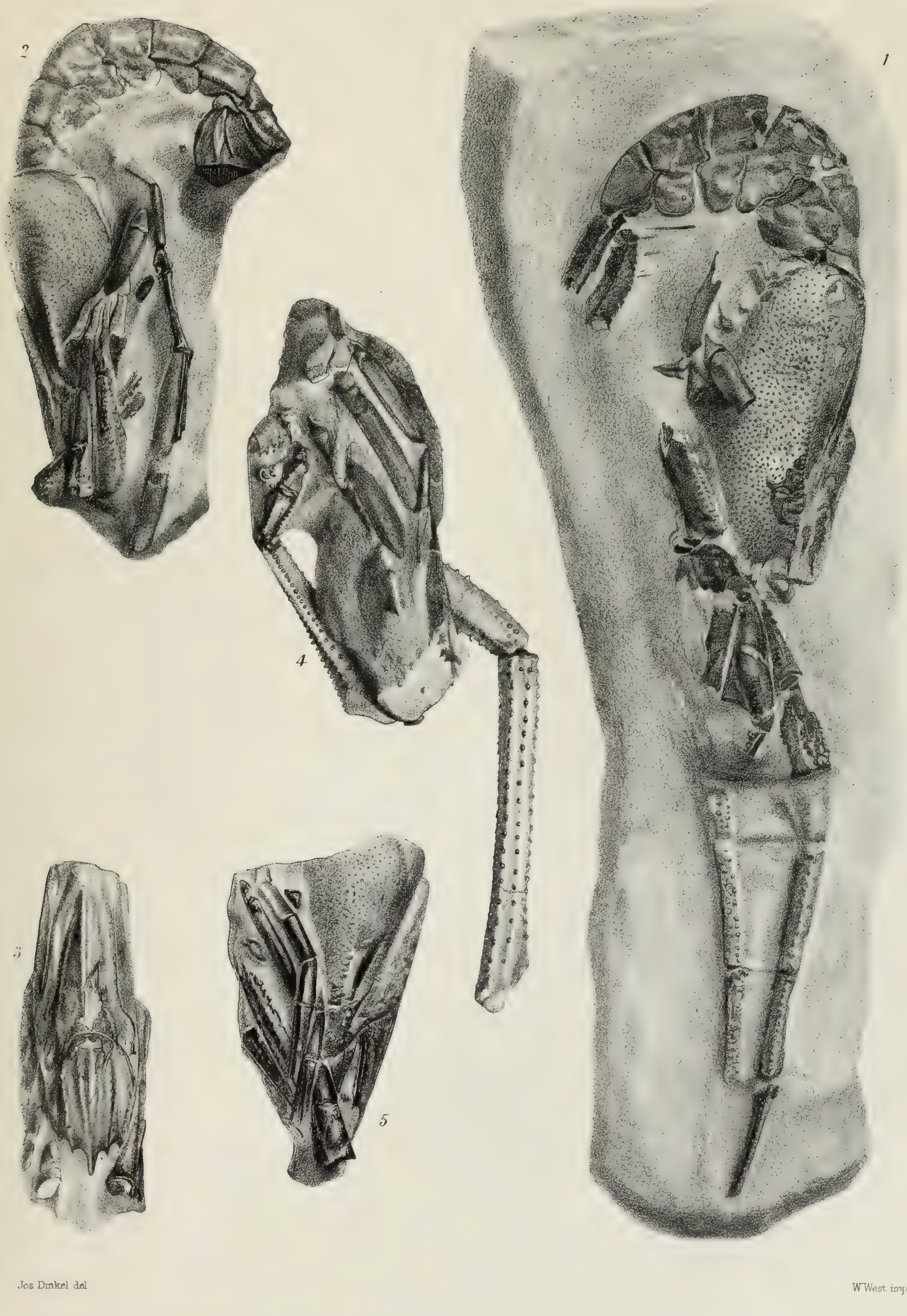

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PLATE XI.

Fig.

1—3. Dorsal views of *Phlyctisoma tuberculatum* (p. 33), showing the linear insulated meso-gastric lobe.

4, 5. Side view of the carapace of the same.

6. Part of the carapace, and the abdomen of the same.

7, 8. Portions of the arms, wrist, and hand of the same.

9, 10. Dorsal view of *Phlyctisoma granulatum* (p. 36).

11, 12. Dorsal view of the carapace of *Glyphæa cretacea* (p. 37).

13. Portion of one of the legs of the same species.

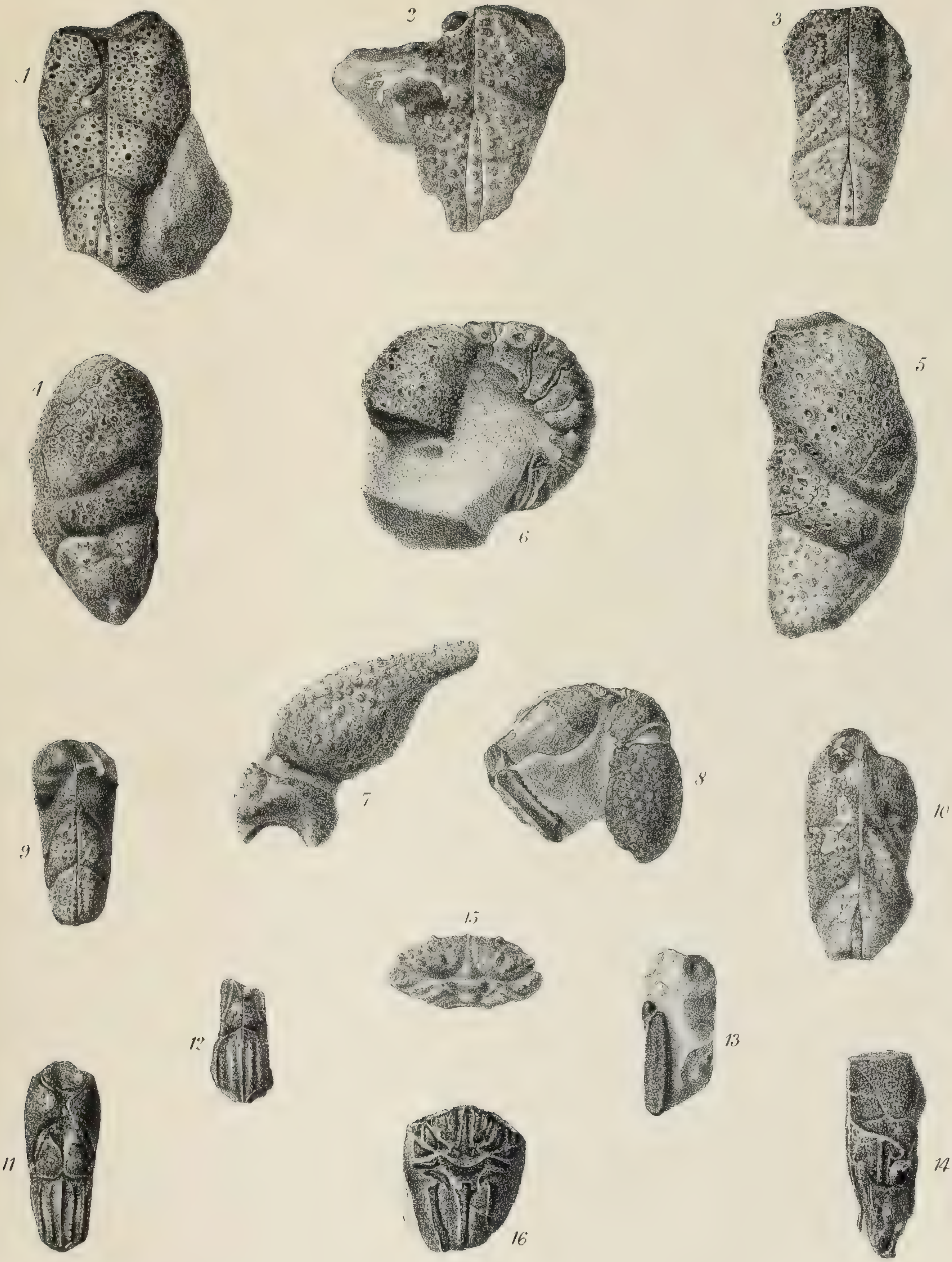
14. Side view of the carapace of *Glyphæa Carteri* (p. 38).

15. *Etyus similis* (p. 39).

16. A remarkable variety of *Eucorystes Carteri* (p. 39).

The specimens in this Plate are all from the Upper Greensand at Cambridge, and in the collection of Mr. Carter.

Plate XI.



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